

# ELECTRICAL WIRES AND CABLES

Catalogue and Handbook  
Systems of Wiring

American Steel & Wire Company  
*Subsidiary of United States Steel Corporation*



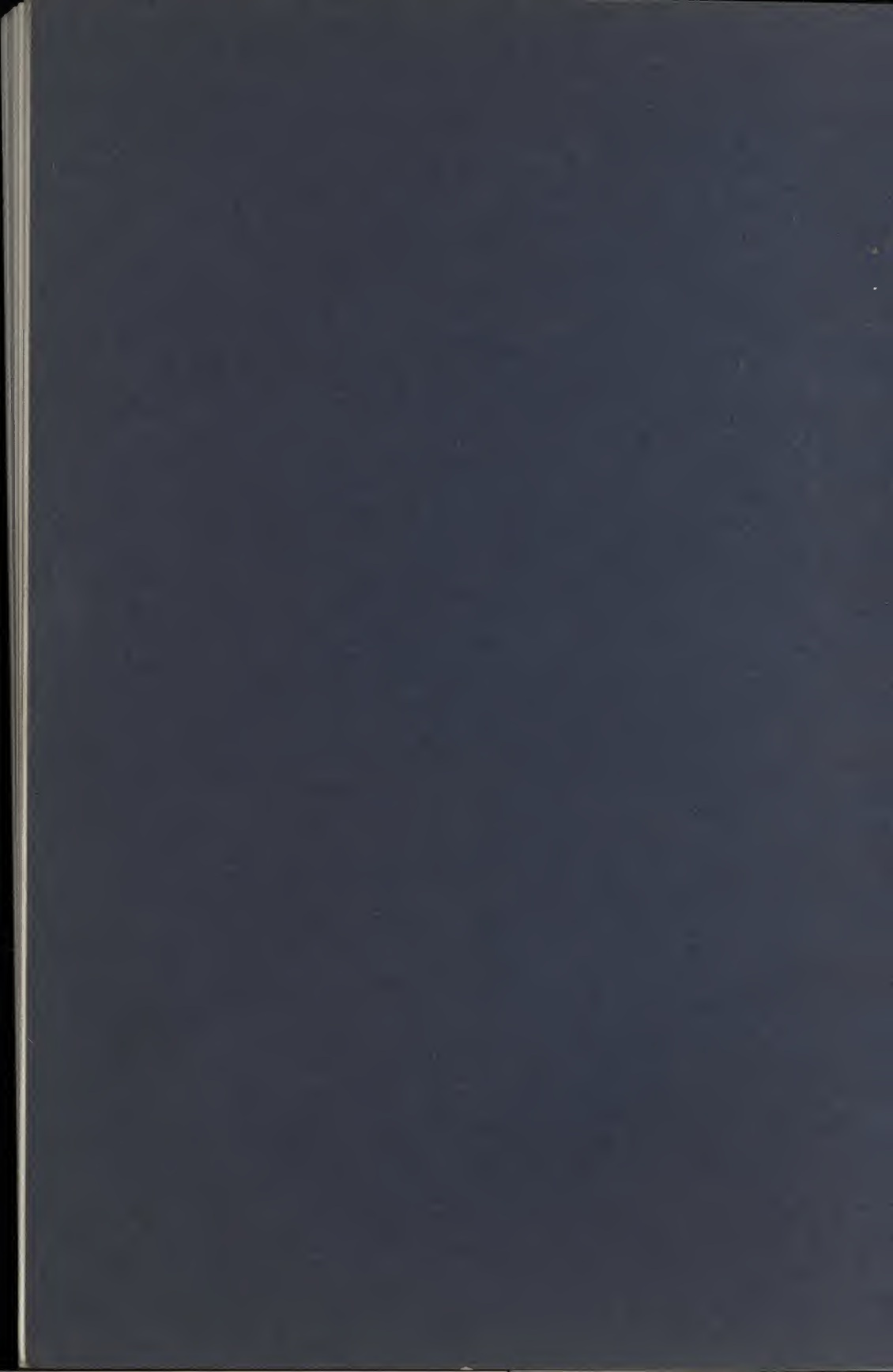
Digitized by

The Association for Preservation Technology International

For the

Building Technology Heritage Library

<http://archive.org/details/buildingtechnologyheritagelibrary>





C.1924

\$350

# American Steel & Wire Company

*Subsidiary of United States Steel Corporation*

## Sales Offices:

CHICAGO . . . . .	208 So. La Salle Street
NEW YORK . . . . .	30 Church Street
WORCESTER . . . . .	94 Grove Street
BOSTON . . . . .	Statler Building
PHILADELPHIA . . . . .	Widener Building
PITTSBURGH . . . . .	Frick Building
BUFFALO . . . . .	670 Ellicott Street
DETROIT . . . . .	Foot of First Street
CINCINNATI . . . . .	Union Trust Building
CLEVELAND . . . . .	Rockefeller Building
BALTIMORE . . . . .	32 So. Charles Street
WILKESBARRE, PA. . . . .	Miners Bank Building
ST. LOUIS . . . . .	506 Olive Street
DALLAS . . . . .	Praetorian Building
ST. PAUL-MINNEAPOLIS . . . . .	Merchants Nat'l Bk. Bldg., St. Paul
KANSAS CITY . . . . .	417 Grand Ave.
OKLAHOMA CITY . . . . .	First National Bank Building
ATLANTA . . . . .	101 Marietta Street
BIRMINGHAM, ALA. . . . .	Brown-Marx Building
MEMPHIS . . . . .	Union and Planters Bank Building
DENVER . . . . .	First National Bank Building
SALT LAKE CITY . . . . .	Walker Bank Building

Export Distributors: U. S. Steel Products Co., New York  
 Pacific Coast Distributors: U. S. Steel Products Company  
 San Francisco      Los Angeles      Portland      Seattle



# Catalogue of Electrical Wires and Cables

## INDEX

Amerite Rubber Covered Wires.....	52-54
Americore Rubber Covered and Mining Machine, Locomotive, Stage, Deck and Telephone Wires and Cables.....	27-38
Amparak Specifications .....	49-50
30% Specifications .....	51
Annunciator Wire .....	11
Armature Binding Wire.....	65
Copper Wires and Cables, Bare.....	4
Cords—Lamp, Portable, Brewery, Canvasite, Packing House, Heater.....	20-26
Hand Book of Electrical Wiring.....	69-107
Hemp Core Cables.....	4
Ignition, Lighting and Starting Wires and Cables, for Automobiles, Motor Boats and Airplanes .....	39-40
Lead Covered Cables, Rubber, Paper and Cambric.....	55-58
Locomotive Headlight Wire.....	25
Magnet Wire .....	5-10
Office Wire .....	12
Pole Steps .....	63
Park and Suburban Cables.....	43-48
Rail Bonds .....	60-61
Reels and Spools.....	66-68
Rubber Clad Cords and Cables.....	41-42
Strand .....	63-64
Submarine Cables .....	59
Systems of Wiring.....	109-125
Telegraph and Telephone Wire, Copper.....	4
Telephone and Telegraph Wire, American W. & M.....	61-62
Tinned Copper Wires and Cables.....	4
Transmission Strand .....	4
Trolley Wire .....	3
Weatherproof Wires and Cables, Reliance.....	13-19



## Bare Wires and Cables

## Copper Trolley Wire

Trolley wire generally is made of hard drawn copper in three shapes, round, grooved and figure 8. Though seldom called upon to make trolley wire larger than 4/0 or smaller than 1/0 American Wire Gauge (B. & S.), we are prepared to make other sizes. The various styles and sizes are shown dimensioned below:

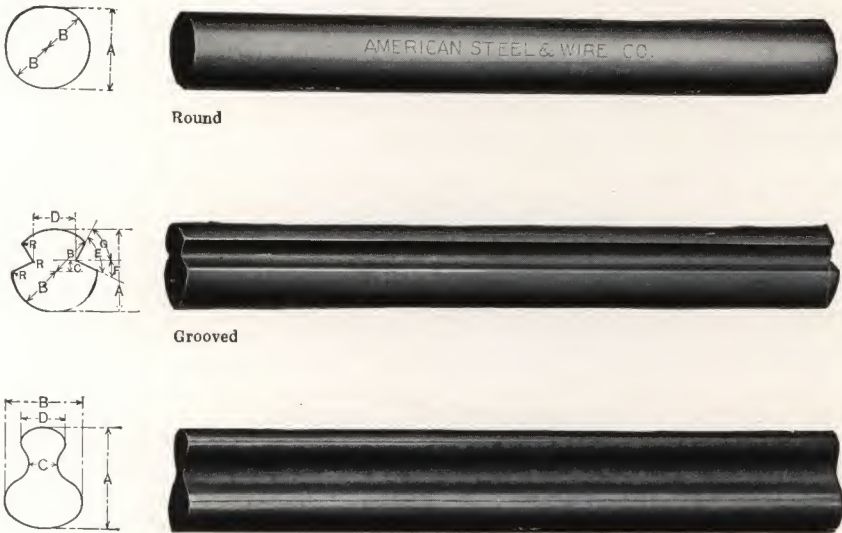


Figure 8

### Dimensions of Hard Drawn Copper Trolley Wire

Section of Trolley Wire	American Wire Gauge (B. & S.)	Sectional Area in Cir. Mills	Approximate Dimensions (See Figures, following page)							
			A	B	C	D	E	F	G	R
Round	0	105,600	.325	.1625	.....	.....	.....	.....	.....	.....
	00	133,200	.365	.1825	.....	.....	.....	.....	.....	.....
	000	168,100	.410	.205	.....	.....	.....	.....	.....	.....
	0000	211,600	.460	.230	.....	.....	.....	.....	.....	.....
Grooved "American Standard"	00	133,200	.392	.196	.03125	.20	78°	27°	51°	.015
	000	168,100	.430	.215	.04688	.22	78°	27°	51°	.015
	0000	211,600	.482	.241	.0625	.25	78°	27°	51°	.015
Figure 8	00	133,200	.480	.352	.108	.196	.....	.....	.....	.....
	000	168,100	.540	.400	.130	.222	.....	.....	.....	.....
	0000	211,600	.600	.450	.150	.250	.....	.....	.....	.....

## Tinned Copper Wires or Cables

Made in all constructions, solid, stranded or flexible.

## Hard Drawn Copper Telegraph and Telephone Wire

American Wire Gauge (B. & S.)			British, Imperial, or English Legal Standard Gauge		
Number	Diameter in Decimal of an Inch	Approx. Weight per Mile in Pounds	Number	Diameter in Decimal of an Inch	Approx. Weight per Mile in Pounds
8	.1285	264	8	.160	409
9	.1144	209	9	.144	331
10	.1019	166	10	.128	262
12	.0808	104	12	.104	173
14	.0641	66	14	.080	102

## Cutting to Lengths

Furnished in any size copper wire cut to special lengths, to be used for tag wire, tie wire, bond wire, or other special purposes. Prices on application.

## Extra Flexible Cables

Our bare copper cables having a high degree of flexibility due to their being made up of a large number of small wires. These cables are used for flexible connectors, for commutator brushes, third rail shoes and similar purposes. They are made both concentric and rope lay.

## Bare Copper Cables

### Concentric or Rope Laid Strand

For constructions and other information see pages 73 and 74.

## Hemp Core Cables

In order to reduce the skin effect in conductors carrying heavy alternating currents of high frequency, it is customary to use a specially constructed cable having a hemp center. This style of cable is also required in many long distance transmission lines in order to increase the diameter enough to prevent corona effects due to very high potentials.

We are prepared to manufacture this style of cable to any specifications.

## Special Transmission Strand

This is a combination of High Strength Steel Wire and Hard Drawn Copper Wire, twisted into a concentric strand of 7, 19, 37, or more wires. The copper wires being on the outside.

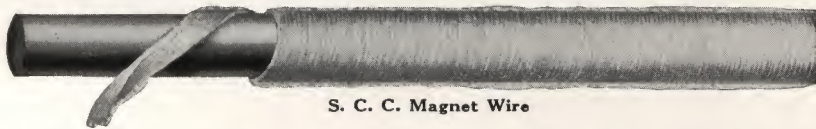
The essential feature of this combination is the high tensile strength it affords.

It is especially useful in cases where it is necessary to stretch the transmission line over long spans.

## Magnet Wire

ALL copper wire drawn for magnet purposes is thoroughly annealed by processes which insure uniform and extreme softness, highest conductivity and ease of handling. Before the insulation is applied all wire is carefully inspected for size and uniformity of dimensions, and to see that it is free from scale and all surface imperfections.

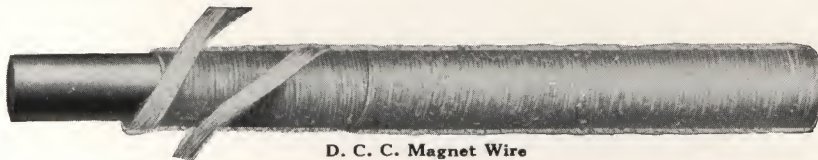
All magnet wire is insulated in special machines by skilled operators. We are not only prepared to produce large quantities of the ordinary commercial sizes of cotton-covered magnet wire, but we are also in a position to and do furnish large amounts of fine sizes and special work, both silk and cotton. The mag-



S. C. C. Magnet Wire

net wire is not only inspected during process, for knots skips, smoothness and evenness of insulation, but it is also given a final thorough inspection and test for continuity before packing. A large supply of the common sizes of magnet wire is constantly kept in stock in our various warehouses.

We cover magnet wire with single, double or triple cotton or silk, with asbestos and cotton and with paper. We also are prepared to make special kinds of magnet wire which may be specified. The effectiveness of these materials for dielectric purposes depends very largely upon their quality and their freedom from foreign or gritty substances. The covers are wound spirally about the wire, successive layers being wound in opposite directions.



D. C. C. Magnet Wire

### Round Cotton Covered Magnet Wire

American Wire Gauge (B. & S.)	Single Cotton-covered		Double Cotton-covered		Triple Cotton-C'd	Approximate Quantity on Reels Pounds
	List Number	Approximate Pounds per 1000 Feet	List Number	Approximate Pounds per 1000 Feet	List Number	
0	5000	321	5100	323	6000	200
1	5001	255	5101	256	6001	150
2	5002	202	5102	203	6002	150
3	5003	160	5103	161	6003	150
4	5004	127	5104	128	6004	150
5	5005	101	5105	102	6005	150
6	5006	80	5106	81	6006	150
7	5007	64	5107	64	6007	150
8	5008	50.4	5108	51	6008	150
9	5009	40.1	5109	40.4	6009	150
10	5010	31.8	5110	32.1	6010	150
11	5011	25.3	5111	25.5	6011	150
12	5012	20	5112	20.3	6012	150
13	5013	16	5113	16.2	6013	150
14	5014	12.6	5114	12.9	6014	150
15	5015	10.1	5115	10.3	6015	150
16	5016	7.96	5116	8.13	6016	50
17	5017	6.35	5117	6.49	6017	50
18	5018	5.04	5118	5.16	6018	50
19	5019	4.01	5119	4.12	6019	12½

## Fine Sizes Round Magnet Wire

American Wire Gauge (B. & S.)	Single Cotton-covered		Double Cotton-covered		Triple Cotton-C'd	Approximate Quantity on Spools Pounds
	List Number	Approximate Pounds per 1000 Feet	List Number	Approximate Pounds per 1000 Feet	List Number	
20	5020	3.20	5120	3.30	6020	12
21	5021	2.55	5121	2.64	6021	12
22	5022	2.02	5122	2.10	6022	11½
23	5023	1.62	5123	1.69	6023	11
24	5024	1.29	5124	1.36	6024	10½
25	5025	1.03	5125	1.10	6025	4
26	5026	.82	5126	.883	6026	4
27	5027	.66	5127	.718	6027	3½
28	5028	.524	5128	.580	6028	3
29	5029	.427	5129	.477	6029	3
30	5030	.336	5130	.382	6030	3
31	5031	.272	5131	.316	6031	2½
32	5032	.220	5132	.260	6032	2½
33	5033	.178	5133	.216	6033	2.3
34	5034	.144	5134	.179	6034	2
35	5035	.119	5135	.150	6035	2
36	5036	.099	5136	.127	6036	2

## Properties of Round Cotton Covered Magnet Wire

### Coarse Sizes

American Wire Gauge (B. & S.)	Diameter Inches	Allowable Variation Either Way in Per Cent	Rated Area in Cir. Mils	Single Cotton-covered Approximate Values		Double Cotton-covered Approximate Values	
				Outside Diameter Inches	Approximate Pounds per 1000 Feet	Outside Diameter Inches	Approximate Pounds per 1000 Feet
0	0.3249	½ of 1	105,625	.333	321	.339	323
1	.2893	½ of 1	83,694	.297	255	.303	256
2	.2576	½ of 1	66,358	.266	202	.272	203
3	.2294	¾ of 1	52,624	.237	160	.243	161
4	.2043	¾ of 1	41,738	.212	127	.218	128
5	.1819	¾ of 1	33,088	.190	101	.196	102
6	.1620	¾ of 1	26,244	.170	80	.176	81
7	.1443	¾ of 1	20,822	.152	64	.158	64
8	.1285	1	16,512	.137	50.4	.142	51
9	.1144	1	13,087	.120	40.1	.125	40.4
10	.1019	1	10,384	.108	31.8	.113	32.1
11	.0907	1	8,226	.097	25.3	.102	25.5
12	.0808	1¼	6,528	.087	20	.092	20.3
13	.0720	1¼	5,184	.078	16	.083	16.2
14	.0641	1¼	4,108	.070	12.6	.075	12.9
15	.0571	1½	3,260	.063	10.1	.068	10.3
16	.0508	1½	2,580	.0553	7.96	.0598	8.13
17	.0453	1½	2,052	.0498	6.35	.0543	6.49
18	.0403	1½	1,624	.0448	5.04	.0493	5.16
19	.0359	1¾	1,288	.0404	4.01	.0449	4.12

# Properties of Round Cotton Covered Magnet Wire

## Fine Sizes

American Wire Gauge (B. & S.)	Diameter Inches	Allowable Variation Either Way in Per Cent	Rated Area in Cir. Mills	Single Cotton-covered Approximate Values		Double Cotton-covered Approximate Values	
				Outside Diameter Inches	Approximate Pounds per 1000 Feet	Outside Diameter Inches	Approximate Pounds per 1000 Feet
20	.0320	1 $\frac{3}{4}$	1.024	.0365	3.20	.0410	3.30
21	.0285	1 $\frac{3}{4}$	812.2	.0330	2.55	.0375	2.64
22	.0253	1 $\frac{3}{4}$	640.0	.0298	2.02	.0343	2.10
23	.0226	2	510.7	.0271	1.62	.0316	1.69
24	.0201	2	404.0	.0246	1.29	.0291	1.36
25	.0179	2	320.4	.0224	1.03	.0269	1.10
26	.0159	2	252.8	.0204	.82	.0249	.883
27	.0142	2	201.6	.0187	.66	.0232	.718
28	.0126	2	158.7	.0171	.524	.0216	.580
29	.0113	2	127.6	.0158	.427	.0203	.477
30	.0100	2 $\frac{1}{2}$	100.0	.0140	.336	.0185	.382
31	.0089	3	79.74	.0129	.272	.0174	.316
32	.0080	3	63.20	.0120	.220	.0165	.260
33	.0071	3	50.13	.0111	.178	.0156	.216
34	.0063	3 $\frac{1}{2}$	39.69	.0103	.144	.0148	.179
35	.0056	4	31.47	.0096	.119	.0141	.150
36	.0050	4 $\frac{1}{2}$	25	.0090	.099	.0135	.127

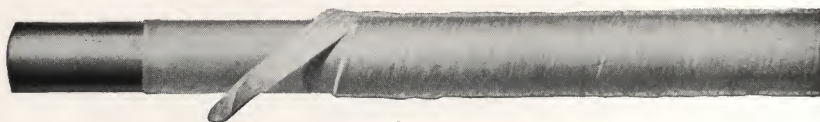
# Fine Sizes Silk Covered Round Magnet Wire

American Wire Gauge (B. & S.)	Single Silk		Double Silk		Triple Silk
	List Number	Approximate Quantity on Spools Pounds	List Number	Approximate Quantity on Spools Pounds	List Number
20	5220	14	5320	12	6120
21	5221	13 $\frac{1}{2}$	5321	12	6121
22	5222	13	5322	11 $\frac{1}{2}$	6122
23	5223	12	5323	11	6123
24	5224	11	5324	10 $\frac{1}{2}$	6124
25	5225	4 $\frac{1}{2}$	5325	4	6125
26	5226	4	5326	4	6126
27	5227	3 $\frac{1}{2}$	5327	3 $\frac{1}{2}$	6127
28	5228	3	5328	3	6128
29	5229	3	5329	3	6129
30	5230	3	5330	3	6130
31	5231	2 $\frac{1}{2}$	5331	2 $\frac{1}{2}$	6131
32	5232	2 $\frac{1}{2}$	5332	2 $\frac{1}{2}$	6132
33	5233	2 $\frac{1}{4}$	5333	2 $\frac{1}{4}$	6133
34	5234	2	5334	2	6134
35	5235	2	5335	2	6135
36	5236	2	5336	2	6136

## Properties of Fine Sizes Silk Covered Round Magnet Wire

American Wire Gauge (B. & S.)	Diameter Inches	Area Cir. Mils	Single Silk			Double Silk		
			Maximum Outside Diameter Inches	Approximate Feet per Pound	Approximate Pounds per 1000 Feet	Maximum Outside Diameter Inches	Approximate Feet per Pound	Approximate Pounds per 1000 Feet
20	.0320	1.024	.0338	316	3.14	.0356	313	3.184
21	.0285	812.2	.0303	398	2.496	.0321	393	2.533
22	.0253	640.0	.0272	502	1.97	.0290	492	2.004
23	.0226	510.7	.0244	632	1.576	.0262	623	1.606
24	.0201	404	.0219	796	1.25	.0237	781	1.277
25	.0179	320.4	.0197	1000	.994	.0215	977	1.018
26	.0159	252.8	.0177	1258	.7865	.0195	1233	.8085
27	.0142	201.6	.0160	1569	.6297	.0178	1531	.6477
28	.0126	158.7	.0144	1996	.497	.0162	1934	.514
29	.0113	127.6	.0131	2463	.4023	.0149	2380	.4162
30	.0100	100.0	.0118	3125	.3163	.0136	3003	.3294
31	.0089	79.70	.0107	3906	.2539	.0125	3731	.2661
32	.0080	63.20	.0098	4878	.2022	.0116	4651	.213
33	.0071	50.13	.0089	6060	.162	.0107	5714	.1723
34	.0063	39.69	.0081	7575	.1301	.0099	7092	.1397
35	.0056	31.47	.0074	9433	.1043	.0092	8695	.1138
36	.0050	25.	.0068	11627	.0837	.0086	10637	.0936

## Asbestos and Single Cotton Covered



Round Asbestos and S. C. C. Magnet Wire

American Wire Gauge (B. & S.)	List Number for Asbestos and Single Cotton Covered	Approximate Pounds per 1000 Feet	*Approximate Diameter Over Insulation Inches	Approximate Quantity on Reels Pounds
0	5400	325.2	.351	150
1	5401	258.2	.315	150
2	5402	205.2	.284	150
3	5403	163.2	.255	150
4	5404	129.9	.230	150
5	5405	103.3	.208	150
6	5406	82.27	.188	150
7	5407	65.6	.170	150
8	5408	52.31	.155	150
9	5409	41.63	.140	150

A very thin asbestos tape is first applied to the wire. This tape is strong and flexible and uniform in texture. It serves as an excellent fire protection. One or two cotton winds are generally put over the asbestos tape. This magnet wire is used largely for railway motor purposes.

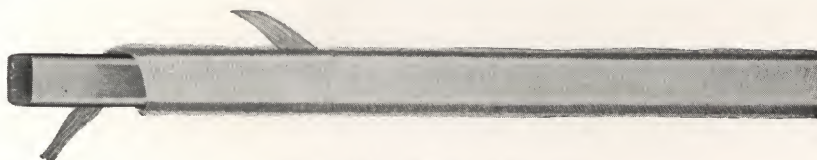
\*Possible variation,  $2\frac{1}{2}$  mils either way.

## Rectangular Magnet Wire



Double Cotton Covered

## Square Magnet Wire



Square Magnet Wire, D. C. C.

Order by list numbers

American Wire Gauge (B. & S.)	List Number	Approximate Radius of Corners Inches	Approximate Dimension Over Insulation Double Cotton Covered	Approximate Pounds per 1000 Feet	Approximate Quantity on Reel Pounds	Shipped on Reel Number
0000	5540	$\frac{1}{16}$	.483	808.7	150	421
000	5530	$\frac{1}{16}$	.433	639.1	150	421
00	5520	$\frac{1}{16}$	.388	504.5	150	421
0	5500	$\frac{1}{16}$	.348	398.2	150	421
1	5501	$\frac{1}{16}$	.312	313	150	444
2	5502	$\frac{1}{16}$	.281	245.8	150	444
3	5503	$\frac{1}{16}$	.252	192.4	150	444
4	5504	$\frac{3}{64}$	.227	155.9	150	444
5	5505	$\frac{3}{64}$	.205	122	150	444
6	5506	$\frac{1}{32}$	.183	99.5	150	444
7	5507	$\frac{1}{32}$	.163	78.3	150	444
8	5508	$\frac{1}{32}$	.146	61.4	150	444
9	5509	$\frac{1}{32}$	.129	50	150	444
10	5510	.025	.115	39.4	150	444
11	5511	.025	.103	31	150	444
12	5512	.025	.093	24.4	150	444
13	5513	.025	.083	19.2	150	444
14	....	.025	.075	15.0	150	444

Each side measures the same as the diameter of round wire of corresponding gauge number.  
Copper 98 per cent conductivity, and annealed extremely soft. Used largely in street railway motors.

## Plain Enamel Magnet Wire

Enameled magnet wire consists of copper wire having a coat of enamel baked thereon and is used for many purposes where cotton and silk covered magnet wire are undesirable. We are prepared to manufacture enamel magnet wire in sizes ranging from 16 to 34 in considerable quantities. Our equipment for making this product embodies the very latest design of apparatus and the enamel used in our wire is of the highest grade, specially compounded for this purpose.

Enameled wire is manufactured by passing soft copper wire through an enamel bath, then through a baking process and repeating both operations until the desired thickness of enamel coatings is obtained. The insulation thus secured is so flexible that the wire will permit winding around a mandrel not larger than twice its own diameter without cracking of insulation. The fine sizes may be wound around a mandrel of their own diameters without showing injurious effect. It will also permit wire being stretched longitudinally 10 per cent of its original length without deleterious effects upon the enamel coating.

## Enamel and Single and Enamel and Double Cotton Covered Magnet Wire

This wire is insulated as described above and covered with one or two winds of cotton. Makes a good substitute for Double Silk Magnet wire, and is sometimes used in place of the impregnated Single or Double Cotton Covered magnet wire. Principally used in motor starting and lighting devices.

Size American Wire Gauge (B & S.)	PLAIN ENAMELED				ENAMELED AND SINGLE COTTON COVERED				ENAMELED AND DOUBLE COTTON COVERED				Reel No.
	Approx. Outside Diam. in Inches	Approx. Pounds per 1,000 Feet	Net Weight of Copper per 100 lbs. of Finished Wire	Approx. Quantity per Spool in Pounds	Approx. Outside Diameter in Inches	Approx. Pounds per 1,000 Feet	Net Weight of Copper per 100 lbs. of Finished Wire	Approx. Pounds per Spool	Approx. Outside Diam. in Inches	Approx. Pounds per 1,000 Feet	Net Weight of Copper per 100 lbs. of Finished Wire	Approx. Pounds per Spool	
16	.0533	7.92	98.5	50	.0578	8.095	96.4	50	.0623	8.265	94.4	50	460
17	.0477	6.306	98.4	50	.0522	6.461	96.0	50	.0567	6.617	93.8	50	460
18	.0426	4.997	98.3	50	.0471	5.136	95.6	50	.0516	5.272	93.1	50	460
19	.0381	3.971	98.1	13 $\frac{1}{4}$	.0426	4.094	95.2	13 $\frac{1}{4}$	.0471	4.203	92.7	13 $\frac{1}{4}$	443
20	.0340	3.159	98.0	13	.0385	3.270	94.7	13	.0430	3.369	91.9	13	443
21	.0305	2.510	97.9	12 $\frac{3}{4}$	.0350	2.613	94.0	12 $\frac{3}{4}$	.0395	2.705	90.8	11 $\frac{3}{4}$	443
22	.0271	1.978	97.8	12 $\frac{1}{4}$	.0316	2.069	93.5	12 $\frac{1}{4}$	.0361	2.155	89.8	11 $\frac{1}{4}$	443
23	.0243	1.580	97.7	12	.0288	1.662	92.9	12	.0333	1.738	88.8	11	443
24	.0216	1.251	97.7	11 $\frac{3}{4}$	.0261	1.324	92.3	11 $\frac{3}{4}$	.0306	1.397	87.5	10 $\frac{3}{4}$	443
25	.0193	.993	97.6	3 $\frac{1}{2}$	.0238	1.060	91.4	3 $\frac{1}{2}$	.0283	1.125	86.2	3	447
26	.0171	.782	97.7	3 $\frac{1}{4}$	.0216	.843	90.7	3 $\frac{1}{4}$	.0261	.910	84.0	2 $\frac{3}{4}$	447
27	.0154	.626	97.4	3 $\frac{1}{4}$	.0199	.680	89.7	3 $\frac{1}{4}$	.0244	.742	82.2	2 $\frac{3}{4}$	447
28	.0136	.492	97.6	3	.0181	.540	88.8	3	.0226	.597	80.5	2 $\frac{3}{4}$	447
29	.0123	.397	97.3	3	.0168	.441	87.6	3	.0213	.495	78.0	2 $\frac{1}{2}$	447
30	.0109	.311	97.2	3	.0154	.351	86.3	3	.0199	.400	75.5	2 $\frac{1}{2}$	447
31	.0097	.248	97.2	2 $\frac{1}{2}$	.0137	.281	85.7	2 $\frac{1}{2}$	.0187	.328	73.5	2	447
32	.0087	.197	97.1	2 $\frac{1}{2}$	.0127	.227	84.1	2 $\frac{1}{2}$	.0172	.270	70.7	2	447
33	.0078	.157	96.9	2	.0118	.185	82.0	2	.0163	.225	67.4	1 $\frac{1}{2}$	447
34	.0069	.124	97.1	2	.0109	.149	80.3	2	.0154	.187	64.2	1 $\frac{1}{2}$	447

## Annunciator Wire

**T**HIS wire, as its name implies, is used in primary battery circuits, for call bell or annunciator wiring in hotels, offices or houses. Commercially pure, soft copper wire varying in size from No. 14 American Wire Gauge (B. & S.) to No. 22 American Wire Gauge (B. & S.) is used. This is insulated with two firm winds of cotton applied in opposite directions and saturated with our specially prepared paraffine wax compound. The outside wrap is made of any color or combination of colors, the most common being bright and fast red or blue with white. This wire is put up on spools weighing about six pounds net.

### Order by List Numbers

American Wire Gauge (B. & S.)	List Number	Approximate Weight per 1000 Feet
14	3114	14.6
16	3116	9.7
18	3118	6.5
20	3120	4.6
22	3122	3.3

## Black Core or Damp-proof Annunciator Wire

Finished in colors as above, shipped on spools of about six pounds net. This wire is made with the inside wind saturated with our weatherproof compound. This permits its use in damp places. The outside wind of cotton which is made in colors is saturated with our special paraffine wax compound, and finished so as to present a smooth and highly polished surface, that will not catch dust.

### Order by List Numbers

American Wire Gauge (B. & S.)	List Number	Approximate Weight per 1000 Feet
14	3214	16.6
16	3216	11.1
18	3218	9.6
20	3220	5.0
22	3222	3.6

## Office Wire

OUR standard grade of office wire consists of a copper conductor, varying in size from 14 American Wire Gauge (B. & S.) to 22 American Wire Gauge (B. & S.), insulated with one wind and one braid of cotton, both of which are applied tight and even. These two cotton covers are thoroughly saturated with our special paraffine wax compound. The outer braid is given a high polish and is made in any color or combination of colors specified. The standard colors are red and white or blue and white. This wire is put up in coils of about 13 to 17 pounds. It is used largely by telephone and telegraph companies for inside wiring, extending from the instruments to the junction where they connect with the outside wires and cables as they enter a building. This wire is also used as a high grade bell and annunciator wire.

Order by List Numbers

American Wire Gauge (B. & S.)	List Number	Approximate Weight per 1000 Feet
14	3314	15.7
16	3316	10.9
18	3318	7.8
20	3320	5.9
22	3322	4.6

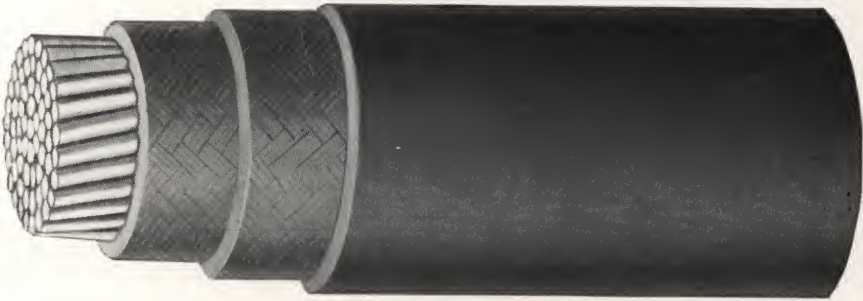
## Black Core or Damp-proof Office Wire

Damp proof office wire has two inside cotton winds applied in opposite directions which are thoroughly impregnated with black weatherproof compound. The outside braid is finished as described above for the regular office wire. This wire is used where a higher grade of insulation is required. It is packed the same as regular office wire.

American Wire Gauge (B. & S.)	List Number	Approximate Weight per 1000 Feet
14	3414	1.9
16	3416	7.9
18	3418	2.6
20	3420	19.5
22	3422	67.1

## Weatherproof Wires and Cables

THERE is a large demand for electrical wires and cables having a moderate degree of insulation and less expensive than rubber insulated conductors. For outdoor service our double and triple braid Reliance Weatherproof wire meets these requirements in every particular, while for indoor purposes we offer a superior grade of Slow Burning wire. We make these wires and cables in strict accordance with all the requirements of the National Board of Fire Underwriters, the sizes varying from No. 18 American Wire Gauge (B. & S.) to the largest feeder cable used.



Stranded Weatherproof Feeder—3-Braid

### Reliance Weatherproof Insulation

The wires are first covered with two or three evenly woven braids of strong fibrous material, after which they are placed in a hot bath of weatherproof insulating compound. They remain in this bath long enough to completely and thoroughly saturate the fibrous insulation. After thoroughly drying, the wire then receives a dressing of mineral wax, after which the surface is thoroughly burished and polished, reducing to a minimum trouble from sleet and ice. The superior grade of compounds used in our Reliance Weatherproof insulation for wires and cables imparts a high degree of dielectric strength, and overcomes the destructive action of the elements. This insulation is firm, durable and tough and possesses great mechanical strength, which enables it to withstand pressure and mechanical abrasion. The compounds contain no solvents which subsequently evaporate, leaving the compound to dry and fall out, thus destroying the insulation. They will withstand all ordinary climatic conditions.

## Reliance Weatherproof Wire

### National Electrical Code Standard



Solid Copper Wire, Double Braid, Black Finish

American Wire Gauge (B. & S.)	Diameter Inches Bare Wire	Area Circular Mils	List Number	Approximate Weights		*Packing	
				Pounds per 1000 Feet	Pounds per Mile	No. Feet	Reel No.
0000	.4600	211600	2040	723	3,817	2,400	467
000	.4096	167772	2030	587	3,098	2,500	467
00	.3648	133079	2020	467	2,467	3,200	467
0	.3250	105625	2000	377	1,989	4,300	467
1	.2893	83694	2001	294	1,553	1,000	422
2	.2576	66358	2002	239	1,264	1,300	422
3	.2294	52624	2003	185	977	1,600	465
4	.2043	41738	2004	151	795	2,100	465
5	.1819	33088	2005	122	646	2,500	422
6	.1620	26244	2006	100	529	3,400	422
8	.1285	16512	2008	66	349	5,000	422
9	.1144	13087	2009	54	283	6,000	422
10	.1019	10384	2010	46	241	2,200	Coils
12	.0808	6528.6	2012	30	158	3,300	Coils
14	.0641	4108.8	2014	20	107	5,000	Coils
16	.0508	2580.6	2016	16	83	3,200	Coils
18	.0403	1624.1	2018	12	64	4,000	Coils

The above standard weights have been adopted because wires having those weights endure longest in service and suit the largest number of customers. Variations should not exceed 3% over or under.

See pages 81 to 83 for properties of bare copper wire. Also page 66 for information concerning reels.

## Reliance Weatherproof Wire

### National Electrical Code Standard



Solid Copper Wire, Triple Braid, Black Finish

American Wire Gauge (B. & S.)	Minimum Thickness of Insulation Inches	List Number	Approximate Weights		*Packing	
			Pounds per 1000 Feet	Pounds per Mile	No. Feet	Reel No.
0000	.0781	2140	767	4,050	2,400	415
000	.0781	2130	629	3,320	2,500	415
00	.0781	2120	502	2,650	3,200	415
0	.0781	2100	407	2,150	4,300	415
1	.0781	2101	316	1,670	1,000	422
2	.0625	2102	260	1,370	1,300	422
3	.0625	2103	199	1,050	1,600	465
4	.0625	2104	164	865	2,100	465
5	.0625	2105	135	710	2,500	422
6	.0625	2106	112	590	3,400	422
8	.0469	2108	75	395	5,000	422
9	.0469	2109	62	325	6,000	422
10	.0469	2110	53	280	2,000	Coils
12	.0469	2112	35	185	3,000	Coils
14	.0469	2114	25	130	4,000	Coils
16	.0469	2116	20	105	2,500	Coils
18	.0469	2118	16	85	3,000	Coils

The above standard weights have been adopted because wires having those weights endure longest in service and suit the largest number of customers. Variations should not exceed 3% over or under.

See pages 81 to 83 for properties of bare copper wire. Also page 66 for information concerning reels.

\*Sizes 1 to 9 may also be furnished in coils if desired.

## Data Concerning Solid Copper Weatherproof In Coils

American Wire Gauge (B. & S.)	Approximate Weight per Coil, Pounds		Approximate Outside Diameter of Coil Inches	Approximate Diameter of Eye of Coil Inches	Approximate Thickness of Coil Inches	Covering of Coil	How Shipped
	2 Braids	3 Braids					
0000	360	383	30 to 34	19	7½	Paper and Burlap	Loose Coils
000	294	315	30 to 34	19	7½		
00	326	350	30 to 34	19	7½		
0	301	325	30 to 34	19	7½		
1	294	316	30 to 34	19	7½		
2	310	338	30 to 34	19	7½		
3	305	330	30 to 34	19	7½		
4	317	344	30 to 34	19	7½		
5	317	350	30 to 34	19	7½		
6	170	180	30 to 34	19	6		
8	171	195	30 to 34	19	6		
10	100	100	20 to 22	12	5	Paper	Coils Packed in Barrels
12	100	100	20 to 22	12	5		
14	100	100	20 to 22	12	5		
16	50	50	20 to 22	12	5		
18	50	50	20 to 22	12	5		

## Reliance Weatherproof Cables



**National Electrical Code Standard**  
**Stranded Copper Conductors—Double Braid—Black Finish**  
**Order by List Numbers**

Circular Mils	Number and Diameter of Wires in Strand Inches	Diameter Bare Strand Inches	List Number	Approximate Weights	
				Pounds per 1000 Feet	Pounds per Mile
2,000,000	91x.1482	1.6302	2250	6690	35,323
1,750,000	91x.1386	1.5246	2251	5894	31,119
1,500,000	91x.1284	1.4124	2252	5098	26,915
1,250,000	91x.1172	1.2892	2253	4264	22,516
1,000,000	61x.1280	1.1520	2254	3456	18,246
900,000	61x.1215	1.0935	2257	3127	16,513
800,000	61x.1145	1.0305	2259	2799	14,779
750,000	61x.1109	.9981	2260	2635	13,919
700,000	61x.1071	.9639	2261	2471	13,045
600,000	61x.0992	.8928	2263	2093	11,052
500,000	37x.1162	.8134	2265	1765	9,318
450,000	37x.1103	.7721	2267	1601	8,452
400,000	37x.1040	.7280	2268	1436	7,584
350,000	37x.0973	.6811	2269	1248	6,589
300,000	19x.1257	.6285	2270	1083	5,721
250,000	19x.1147	.5735	2271	907	4,788
American Wire Gauge (B. & S.)					
0000	19x.1055	.5275	2240	745	3,935
000	19x.0940	.4700	2230	604	3,190
00	7x.1378	.4134	2220	482	2,544
0	7x.1228	.3684	2200	388	2,051
1	7x.1093	.3279	2201	303	1,599
2	7x.0973	.2919	2202	246	1,301
3	7x.0867	.2601	2203	190	1,004
4	7x.0772	.2316	2204	155	820
5	7x.0687	.2061	2205	126	668
6	7x.0612	.1836	2206	103	544
8	7x.0485	.1455	2208	68	359

The above standard weights have been adopted because wires having those weights endure longest in service and suit the largest number of customers. Variations should not exceed 3% over or under. See page 66 for information concerning reels.

## Reliance Weatherproof Cables



Stranded Copper Conductors—Triple Braid—Black Finish

### National Electrical Code Standard

Circular Mills	Minimum Thickness of Insulation Inches	List Number	Approximate Weight		*Packing	
			Pounds per 1000 Feet	Pounds per Mile	No. Feet	Reel No.
2,000,000	.1250	2350	7008	37,000	600	468
1,750,000	.1250	2351	6193	32,700	700	468
1,500,000	.1250	2352	5380	28,400	850	468
1,250,000	.1250	2353	4508	23,800	1000	468
1,000,000	.1250	2354	3674	19,400	1320	468
900,000	.1094	2357	3332	17,600	1320	468
800,000	.1094	2359	2992	15,800	1320	468
750,000	.1094	2360	2822	14,900	1320	468
700,000	.1094	2361	2650	14,000	1320	468
600,000	.1094	2363	2235	11,800	1320	468
500,000	.1094	2365	1894	10,000	1320	468
450,000	.0938	2367	1724	9,100	1320	468
400,000	.0938	2368	1553	8,200	1320	468
350,000	.0938	2369	1345	7,100	2640	468
300,000	.0938	2370	1174	6,200	2640	468
250,000	.0938	2371	985	5,200	2640	468
American Wire Gauge (B. & S.)						
0000	.0781	2340	800	4,220	2000	467
000	.0781	2330	653	3,450	2000	467
00	.0781	2320	522	2,760	3000	467
0	.0781	2300	424	2,240	3000	467
1	.0781	2301	328	1,735	1000	422
2	.0625	2302	270	1,425	1300	422
3	.0625	2303	206	1,090	1600	465
4	.0625	2304	170	900	2100	465
5	.0625	2305	140	740	3000	422
6	.0625	2306	115	610	3400	422
8	.0469	2308	78	410	5000	422

The above standard weights have been adopted because wires having those weights endure longest in service and suit the largest number of customers. Variations should not exceed 3% over or under.

\*Sizes 1 to 8 may also be furnished in coils if desired.

## Reliance Slow Burning Wires and Cables

This, as its name implies, has an insulation that will not carry flame. It is especially useful in hot dry places where ordinary insulations would perish, and where wires are brought together, as on the back of a large switchboard or in a wire tower, where the accumulation of rubber or weatherproof insulations would result in an objectionably large mass of highly inflammable material.

This wire is made in strict accordance with the requirements of the National Board of Fire Underwriters in all respects. Each insulating braid is completely saturated with our white slow burning compound, and the outside is thoroughly slicked down and given a hard, smooth, white surface.

## Reliance Slow Burning Wires and Cables

Stranded Conductor—Triple Braid—White Finish

National Electrical Code Standard

Order by List Numbers

Prices Quoted on Application

Circular Mils	Stranded			Packing	
	List Number	Approximate Weights		No. Feet	Reel No.
		Pounds per 1000 Feet	Pounds per Mile		
1,500,000	2402A	5558	29346	500	468
1,250,000	2403A	4719	24916	500	468
1,000,000	2404A	3889	20534	1000	468
900,000	2406A	3553	18760	1000	468
800,000	2408A	3216	16980	1000	468
750,000	.....	3040	16051	1000	468
600,000	2412A	2401	12677	1000	468
500,000	2414A	2067	10914	1000	467
400,000	2416A	1651	8717	1000	467
300,000	2418A	1303	6880	1000	467

Number of wires in strand same as in weatherproof cables.  
Variation in weight should not exceed 5% over or under.

## Reliance Slow Burning Wires and Cables

American Wire Gauge B. & S.	Stranded			Solid			Packing	
	List No.	Approx. Weights		List No.	Approx. Weights		No. Feet	Reel No.
		Pounds per 1000 Feet	Pounds per Miles		Pounds per 1000 Feet	Pounds per Mile		
0000	2640	895	4726	2440	866	4572	2000	467
000	2630	746	3939	2430	698	3685	2000	467
00	2620	564	2978	2420	552	2915	2500	467
0	2600	471	2487	2400	463	2445	2500	467
1	2601	394	2080	2401	386	2038	1000 to 1500	422
2	2602	335	1770	2402	327	1727	1000 to 1500	422
4	2604	209	1104	2404	201	1061	1000 to 1500	465
6	2606	154	813	2406	151	797	1000 to 1500	465
8	.....	.....	.....	2408	94	496	500	Coils
10	.....	.....	.....	2410	72	380	500	Coils
12	.....	.....	.....	2412	50	264	1000	Coils
14	.....	.....	.....	2414	41	216	1000	Coils

Variation in weight should not exceed 5% over or under.

## Special Weatherproof and Slow Burning Wires



Stranded Copper Conductor, Triple Braid, White Finish

Conductors for special purposes are often required to have a combined insulation of black weatherproof and white slow burning coverings. The wires may have a single coating of each kind, or they may have three coatings, two of slow burning and one of weatherproof, or conversely, as may be specified. The several braids are closely and evenly woven and of the proper thickness as required by the National Board of Fire Underwriters.

When the weatherproof covering is on the inside, the conductor is known generally as "White Finish Weatherproof," and when the flame-proof covering is on the inside it is called "Black Finish Slow Burning." The weatherproof and the slow burning compounds used to impregnate these braids are the same as used on our "Reliance" Weatherproof and Slow Burning wires. In all cases the outside surfaces are finished smooth and hard, and the finished saturated braids present a high degree of insulation and are strong, durable and elastic.

We are also prepared to furnish any of these various kinds of weatherproof or slow burning wires twisted into pairs, or formed into cables having any number of conductors, the conductors so formed being encased in one or more finished braids or with tape and braid, as may be specified.

## Reliance Weatherproof Iron Wire



Double Braid

Order by List Numbers

Prices Quoted on Application

Birmingham Wire Gauge	List Numbers		Approximate Weight per 1000 Feet	Approximate Weight per Mile	Approximate Length of Coil Feet
	B. B. Extra Galvanized	Extra B. B. Extra Galvanized			
8	2708	2808	88	465	2640
9	2709	2809	71	375	2640
10	2710	2810	60	317	2640
12	2712	2812	43	227	2640
14	2714	2814	29	153	2640

## Reliance Weatherproof Iron Wire



Triple Braid

Order by List Numbers

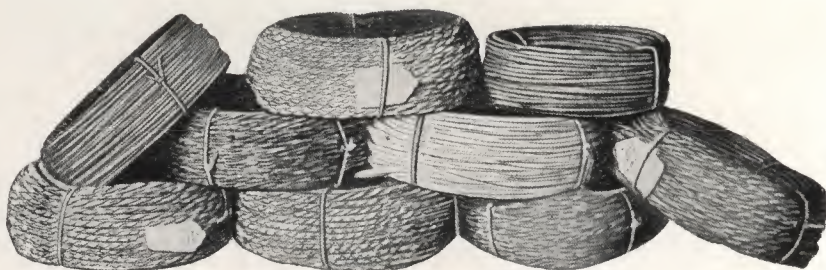
Birmingham Wire Gauge	List Numbers		Approximate Weight		Approximate Length of Coil Feet
	B. B. Extra Galvanized	Extra B. B. Extra Galvanized	Per 1000 Feet	Per Mile	
8	2908	3008	100	528	2640
9	2909	3009	78	412	2640
10	2910	3010	67	354	2640
12	2912	3012	49	259	2640
14	2914	3014	35	185	2640

Uses: For fire alarm, telephone, telegraph and burglar alarm construction, where danger of short circuits with other wires or trees exists.

## Data Concerning Weatherproof Iron Wire In Coils

Birmingham Wire Gauge	Approximate Weight per Coil Pounds		Approx. Outside Diameter of Coil Inches	Approx. Diameter of Eye of Coil Inches	Approximate Thickness of Coil Inches		Covering of Coil	How Shipped	Approx. Length in a Coil Feet
	2 Braids	3 Braids			2 Braids	3 Braids			
8	233	264	30 to 34	19	6	7½	Bur-lapped	Loose Coils	2640
9	188	206	30 to 34	19	6	7½			2640
10	159	177	30 to 34	19	6	7½			2640
12	114	130	30 to 34	19	6	7½			2640
14	77	93	22 to 24	12	5	5			2640

## Cords



Lamp Cord in Bundles of 250 feet

**INCANDESCENT LAMP CORD** is used in short lengths for exposed wiring in offices and residences to connect the concealed wiring with drop lights, brackets and portables. It is also used for bell and annunciator wiring, and for other purposes where a short flexible connecting conductor having an ornamental insulation would be desirable.

The conductor consists of a number of small untinned annealed copper wires, each No. 30 American Wire Gauge (B. & S.), having a diameter of .01 inch, twisted into a cable of the required carrying capacity. This conductor is then covered with a tight, close wind of fine cotton, after which it is insulated with seamless rubber and then covered with an ornamental braid of silk, artificial silk or cotton. Two of these finished conductors are then twisted about each other, or in some cases they are laid parallel and braided over all with silk, artificial silk or cotton, in each case forming the two branches of a circuit.

All sizes put up in coils of 250 feet each. Sizes 16 and 18 have the largest sale, and are put up in packages containing 1000 feet and 3000 feet each, as desired. Coils will be packed in specially prepared paper cartons, upon request.

A combination of green and yellow is the color usually furnished for Cotton Covered Lamp Cords; Portable Cords generally furnished with Dry Black Cotton Braid. Other colors to order.

### Americore Lamp Cord and Reinforced Cord

#### National Electric Code Standard

**T**HE following data is an extract from the National Board of Underwriters' Specifications, and covers our Americore (new code) Lamp Cord and Portable Cord.

#### Type C.

**For Pendant Lamps** — In this class is included all flexible cord, which under usual conditions, hangs freely in the air and not likely to be moved sufficiently to come in contact with surrounding objects.

Pendant lamps provided with long cords, so that they can be carried about or hung over nails or on machinery, etc., are not included in this class, even though they are usually allowed to hang freely.

Each conductor must have an approved braided covering so put on and sealed in place that when cut it will not fray out.

This type is insulated with  $\frac{3}{64}$  inch rubber on sizes 8 to 14 and  $\frac{1}{32}$  on 16 to 22.

**Type C. W. P.**

Same as Type C except must have saturated braid and  $\frac{3}{64}$  inch rubber. For use in damp places.

**Type P. O.**

**For Pendant Lamps** — Parallel cord — Each conductor TYPE C, except soft cotton braid, two such conductors laid parallel and covered with one silk, artificial silk or cotton braid.

**Type P. D.**

**For Pendant or Portables** — Twisted Pair — Each conductor TYPE C, except soft cotton braid, two such conductors twisted together and covered over all with glazed cotton, artificial silk or silk braid.

**Type P.**

**For Portables** — Flexible cord for portable use, except in offices, dwellings or similar places where cord is not liable to rough usage and where good appearance is an essential feature, must meet all the requirements for flexible cord for pendants, and in addition must have a tough-braided cover over the whole. There must also be an extra layer of rubber between the outer cover and the flexible cord. All sizes (except No. 14 and larger) are insulated with  $\frac{1}{32}$  inch rubber; No. 14 and larger have  $\frac{3}{64}$  inch rubber.

**Type P. W. P.**

**For Portables in Damp Places** — (Same as TYPE P except must be furnished with a saturated braid.) For use in damp places, the insulation must be  $\frac{3}{64}$  inch thick on sizes No. 14 and larger, and  $\frac{1}{32}$  inch on sizes No. 16 and smaller, and the cord must have an outer covering saturated with a moisture-proof preservative compound thoroughly slicked down, or must have a filler of approved material instead of an extra layer of rubber, and have two outer braids saturated with a moisture-proof compound with an exterior surface thoroughly slicked down.

**Type PL**

**Light Portable Cord** — For pendant or portable use in offices, dwellings and similar dry places where not likely to be subjected to severe usage. Twisted pair with no braids on the individual conductors; jacket of Americore (Code) rubber not less than  $\frac{1}{64}$  inch thick around the twisted pair, outer covering of glazed cotton or silk. Insulation not less than  $\frac{1}{32}$  inch for No. 18 and 16 B. & S. gage; for larger sizes the same as for rubber covered wire.

**Type P. S.**

**For Portables in Dwellings, Offices, etc.** — In offices, dwellings or similar places where cords are not liable to rough usage and where good appearance is essential, flexible cord for portable use must meet all of the requirements for flexible or for pendant lamps both as to construction and thickness of insulation, and in addition must have a tough-braided cover over the whole; or providing there is an extra layer of rubber between the flexible cord and the outer cover, the insulation proper on each stranded conductor of cord may be  $\frac{1}{64}$  inch in thickness instead of as required for pendant cords.

NOTE: This cord has only  $\frac{1}{64}$  inch rubber on each conductor, and is no longer approved by underwriters. The supplementary insulation is same as on other portable cords.

**Type P. S. W. P.**

**For Portables** — Same as TYPE P. S. except must be furnished with a saturated braid. Not approved by Underwriters.

## List Numbers, Weights, and Constructions of Lamp Cords and Reinforced Portable Cords



All Americore Lamp cords are made to fully meet the requirements of the National Electric Code Specifications as to quality and thickness of rubber insulation. All of this wire is examined and labeled under the direction of the Underwriters' Laboratories, except where noted. Order by List Number.

### Type C.

American Wire Gauge (B. & S.)	Number Wires	Thickness of Rubber in Inches	Twisted Pair (Type C.)					
			Cotton Covered		Silk Covered		Artificial Silk Covered	
			List Number	Weight	List Number	Weight	List Number	Weight
10	104	3-64	1100	122	....	..	....	..
12	65	3-64	1102	88	....	..	....	..
14	41	3-64	1104	62	1124	59	1604	59
16	26	1-32	1106	36	1126	35	1606	35
18	16	1-32	1108	27	1128	26	1608	26
20	10	1-32	1110	21	1130	21	1610	21
22	6	1-32	1112	18	1132	17	1612	17

### Type P. O.

American Wire Gauge (B. & S.)	Number Wires	Thickness of Rubber in Inches	Duplex Parallel (Type P. O.)					
			Cotton Covered		Silk Covered		Artificial Silk Covered	
			List Number	Weight	List Number	Weight	List Number	Weight
16	26	1-32	1406	37	1426	35	1636	35
18	16	1-32	1408	28	1428	27	1638	27
20	10	1-32	1410	23	1430	21	1640	21
22	6	1-32	1412	19	1432	18	1642	18

### Type P. D.

American Wire Gauge (B. & S.)	Number Wires	Thickness of rubber in Inches	Dry Cotton Braid	
			List No.	Weight
14	41	$\frac{3}{64}$	1134	67
16	26	$\frac{1}{32}$	1136	37
18	16	$\frac{1}{32}$	1138	28
20	10	$\frac{1}{32}$	1140	23

### Types P. and P. W. P.

American Wire Gauge (B. & S.)	Number Wires	Thickness of Rubber in Inches	Dry Cotton Braid (Type P)		Silk Braid (Type P)		Saturated Braid (Type P.W.P.)	
			List No.	Weight	List No.	Weight	List No.	Weight
14	41	3-64x1-64	1164	118	1174	123	1184	123
16	26	1-32x1-64	1166	69	1176	72	1186	73
18	16	1-32x1-64	1168	57	1178	62	1188	61
20	10	1-32x1-64	1170	48	1180	53	1190	52

### Type P. L.

American Wire Gauge (B. & S.)	Number Wires	Thickness of Rubber in Inches	Cotton Covered		Artificial Silk Covered	
			List Number	Weight	List Number	Weight
16	26	1-32x1-64	1436	63	....	..
18	16	1-32x1-64	1438	51	1678	50
20	10	1-32x1-64	1440	43	1680	41

**Type P. S.**

American Wire Gauge (B. & S.)	Number Wires	*Thickness of Rubber in Inches	Dry Cotton Braid (Type P. S.)		Silk Braid (Type P. S.)		Artificial Silk	
			List Number	Weight	List Number	Weight	List Number	Weight
14	41	1-64x1-64	1144	70	....	..	....	..
16	26	1-64x1-64	1146	50	....	..	....	..
18	16	1-64x1-64	1148	39	1158	37	1666	37
20	10	1-64x1-64	1150	32	1160	30	1668	30

**Type P. S. W. P.**

American Wire Gauge (B. & S.)	Number Wires	*Thickness of Rubber in Inches	Saturated Braid	
			List No.	Weight
16	26	$\frac{1}{64} \times \frac{1}{64}$	1196	53
18	16	$\frac{1}{64} \times \frac{1}{64}$	1198	43

\* First figure indicates thickness of rubber on individual conductor; second figure indicates thickness of rubber belt.  
List prices and discounts upon application.

## 1909 Code and Commercial Lamp Cords and Portable Cords Lamp Cords

Number of Wires in Strand Each No. 30 American Wire Gauge (B. & S.)	Equal in Capacity to American Wire Gauge (B. & S.)	1909 Code		Commercial	
		List Number Cotton Covered	List Number Silk Covered	List Number Cotton Covered	List Number Silk Covered
104	10	4010	4110	4210	4310
65	12	4012	4112	4212	4312
41	14	4014	4114	4214	4314
26	16	4016	4116	4216	4316
16	18	4018	4118	4218	4318
10	20	4020	4120	4220	4320
6	22	4022	4122	4222	4322

**Portable Cords (Dry Braid)**

65	12	4612	4712	4612A	4712A
41	14	4614	4714	4614A	4714A
26	16	4616	4716	4616A	4716A
16	18	4618	4718	4618A	4718A
10	20	4620	4720	4620A	4720A

1909 Code insulated with  $\frac{1}{32}$ " vulcanized rubber. Commercial insulated with  $\frac{1}{64}$ " rubber.

**Portable Cords (Saturated Braid)**

Used for portable lamps, small portable motors, or any device which may be carried about. The outer braid is made strong and durable. Made with cotton-covered twisted pair lamp cord, over which is placed a supplementary insulation of vulcanized rubber  $\frac{1}{64}$  inch thick, making the whole cylindrical. This is covered with a strong cotton braid thoroughly saturated with weatherproof compound, then waxed and polished.

**Order by List Numbers**

American Wire Gauge (B. & S.)	List Number	American Wire Gauge (B. & S.)	List Number
12	4812	18	4818
14	4814	20	4820
16	4816	..	....

American (Special) Brewery Cord



Made from the regular twisted lamp cord TYPE C, except soft cotton braid, over which is placed a supplementary insulation of vulcanized rubber  $\frac{1}{64}$  inch thick. It is then braided over with two heavy cotton braids saturated with weatherproof compounds, then waxed and polished. Used for incandescent lighting in breweries and other damp places.

Order by List Numbers

American Wire Gauge (B. & S.)	List Number	American Wire Gauge (B. & S.)	List Number
12	4912	18	4918
14	4914	20	4920
16	4916	..	....

All sizes put up in coils of 500 feet each.

Americore Brewery Cord

Type C. B.



For Low Potential, 0-300 Volts

American Wire Gauge (B. & S.)	Thickness of Rubber Inches	List Number	Approximate Weight per 1000 Feet, Pounds
10	3-64	8930	128
12	3-64	8932	93
14	3-64	8934	68
16	2-64	8936	39
18	2-64	8938	31
20	2-64	8940	25

Specifications: Each conductor regular lamp cord strand, cotton wound, insulated with code thickness of vulcanized rubber, covered with a cotton braid and saturated with weatherproof compound, wax polish finish. Two such finished conductors are then twisted into pairs, forming a flexible cord.

Americore Canvasite Cord

(Type C. C.)



Consists of two conductors, each lamp cord strand insulated with code thickness of vulcanized rubber and covered with a weatherproof cotton braid. These are twisted together and covered with an additional weatherproof braid.

Order by List Numbers

American Wire Gauge (B. & S.)	List Number	Weight per 1000 Feet	American Wire Gauge (B. & S.)	List Number	Weight per 1000 Ft.
14	8914	79	18	8918	36
16	8916	45	20	8920	30

## Americore Packing House Cord

Type P. K. W. P.



Order by List Number

For Low Potential, 0-300 Volts

Prices Quoted on Application

American Wire Gauge (B. & S.)	Thickness of Rubber Inches	List Number	Approximate Weight per 1000 Feet, Pounds
10	3-64	8950L	203
12	3-64	8952L	158
14	3-64	8954L	122
16	2-64	8956L	70
18	2-64	8958L	58
20	2-64	8960L	50

*Specifications:* Each conductor regular lamp cord strand, cotton wound, insulated with vulcanized rubber, covered with a cotton braid, saturated with weatherproof compound. Two such finished conductors twisted into pairs, interstices of which are filled with jute laterals to make the whole cylindrical and then braided over all with two heavy cotton braids, saturated with a weatherproof compound and given a wax polish finish. The Underwriters allow the substitution of a tape for the inner braid in the outer cover. Used for incandescent lighting in packing houses and similar places.



## Special Locomotive Headlight Wire

Headlight Wire is furnished with enameled coated conductor of annealed and cleaned copper. Cotton wound and covered overall with three specially treated flameproof braids. It may be furnished with either solid or stranded conductor, in the latter case the strand itself being enameled and not the individual wires of which the strand is composed. Standard finish black or slate colored.

Size American Wire Gauge (B. & S.)	No. of Wires	Weight per 1000 feet	Out-side Dia.	Pack-ing in Coils	Size American Wire Gauge (B. & S.)	No. of Wires	Weight per 1000 feet	Out-side Dia.	Pack-ing in Coils
10	7	49	.213	1000	10	Solid	48	.199	1000
12	7	36	.188	1000	12	Solid	35	.177	1000
14	7	27	.169	1000	14	Solid	26	.160	1000



## Americore Heater Cord

We manufacture this Cord in six standards—Duplex Heater Cord, known as STANDARDS "A," "C" and "E," and Twisted Pair Heater Cord, known as STANDARDS "B," "D" and "F."

*See next page for Specifications.*

## Specifications for Americore Heater Cord

ILLUSTRATED ON PRECEDING PAGE

### Standard "A"

Conductor made up of flexible A. & C. copper strand *braided*, covered with a cotton wind, insulated with  $\frac{1}{64}$ -inch Americore Rubber and *one asbestos braid*. Two such conductors, one of which contains red tracer twisted together and covered over all with one hard slate grey cotton braid.

### Standard "B"

Conductor made up of flexible A. & C. copper strand *braided*, covered with a cotton wind, insulated with  $\frac{1}{64}$  inch Americore Rubber, *one asbestos braid*, one hard slate grey cotton braid. Two such conductors twisted together, one of which contains red tracer.

### Standard "C"

Conductor made up of flexible A. & C. copper strand *braided*, covered with a cotton wind, insulated with  $\frac{1}{64}$  inch Americore Rubber and *one asbestos wind*. Two such conductors, one of which contains red tracer twisted together and covered over all with one hard slate grey cotton braid.

### Standard "D"

Conductor made up of flexible A. & C. copper strand *braided*, covered with a cotton wind, insulated with  $\frac{1}{64}$  inch Americore Rubber, *one asbestos wind*, one hard slate grey cotton braid. Two such conductors twisted together, one of which contains red tracer.

### Standard "E"

Conductor made up of flexible A. & C. copper strand *bunched*, covered with a cotton wind, insulated with  $\frac{1}{64}$  inch Americore Rubber and *one asbestos wind*. Two such conductors, one of which contains red tracer, twisted together and covered overall with one hard slate grey braid.

### Standard "F"

Conductor made up of flexible A. & C. copper strand *bunched*, covered with a cotton wind, insulated with  $\frac{1}{64}$  inch Americore Rubber, *one asbestos wind*, one hard slate grey cotton braid. Two such conductors twisted together, one of which contains red tracer.

*Remarks:* We are in a position to make other constructions. Price will be furnished upon receipt of full specifications or sample.

	Size American Wire Gauge (B. & S.)	Weight per 1000 Feet	PACKING		Approx. Diameter in Inches	List Number
			Feet	Coils		
Standard "A"	14	50	500	Coils	.391	1804
	16	38	500	Coils	.359	1806
	17	35	500	Coils	.355	1807
	18	31	500	Coils	.345	1808
Standard "B"	14	51	500	Coils	.432	1814
	16	39	500	Coils	.400	1816
	17	36	500	Coils	.346	1817
	18	32	500	Coils	.386	1818
Standard "C"	14	47	500	Coils	.341	1824
	16	34	500	Coils	.309	1826
	17	31	500	Coils	.305	1827
	18	27	500	Coils	.295	1828
Standard "D"	14	48	500	Coils	.382	1834
	16	36	500	Coils	.350	1836
	17	33	500	Coils	.346	1837
	18	29	500	Coils	.336	1838
Standard "E"	12	73	500	Coils	.407	1842
	14	51	500	Coils	.349	1844
	16	36	500	Coils	.315	1846
	17	31	500	Coils	.309	1847
	18	27	500	Coils	.289	1848
Standard "F"	12	73	500	Coils	.448	1852
	14	51	500	Coils	.390	1854
	16	38	500	Coils	.356	1856
	17	33	500	Coils	.350	1857
	18	29	500	Coils	.330	1858



# Americore

## RUBBER COVERED WIRE

### *for* INTERIOR WIRING

ALL SIZES AND VOLTAGES

**R**UBBER-COVERED wire as used for general purposes must possess three essentials—the conductor, the wall of rubber insulation and the braid, tape and braid or other form of protection. The conductor consists of uniformly soft annealed commercially pure copper wire. It may be used in the solid form up to size 1/0 American Wire Gauge (B. & S.), or in special cases even to 4/0, or in the stranded form. All conductors are thoroughly and evenly coated with tin to protect the copper from any injurious effect from the sulphur in the rubber insulation.

### Kinds of Rubber Insulation

We make many grades of rubber compound for rubber-covered conductors: the AMERICORE, compound, made to the Underwriters' Specifications known as the National Electrical Code standard, and AMERITE, a high-grade 30 per cent compound, are the two standard grades. In addition, we insulate wire to any specifications covering particular requirements, such as 20 or 40 per cent rubber compounds. We also make a high-grade compound for lead-encased rubber-covered cables.

**AMERICORE RUBBER.** This rubber has all the desirable qualities of a new code wire. It is a high grade compound, meeting all National Electrical Code requirements and can be recommended for all service conditions in which the working pressure is 7000 volts or under.

**AMPARAK RUBBER** (an intermediate grade). This is a high grade of compound made to suit the demand of engineers, architects and contractors desiring something better than the National Code Wire (Americore) but not so high a quality as Amerite or 30%, etc.

**ASW 30% RUBBER** (A. S. & W. Co. Specification). This is a very high grade of compound made to suit the demand for a wire somewhat higher than the Amparak grade, but not so high a quality as Amerite. It is often called for by contractors and used for the same purposes as Amerite.

**AMERITE RUBBER.** This brand contains only the best grade of pure Hevea rubber, and is used for high voltage circuits. This makes an unsurpassed dielectric for all high voltages and for exacting service conditions; it has great strength and elasticity, high insulation qualities and long life.

Every wire insulated with our standard compounds has a distinguishing woolen tracer thread placed lengthwise of the conductor between the rubber and the braid. In Americore this tracer thread is uncolored, in Amparak, dark green, in Amerite and Standard 30%, crimson.

Specifications for Americore Wire  
National Electric Code

Conductors	To be standard American Wire Gage.
Chemical Test	Five chemical tests Acetone extract Alcoholic potash extract Chloroform extract Ash test Total sulphur Sum of these 5 tests shall not exceed 80% by weight of the total Tests as per Underwriters' procedure
Physical Test	NEW WIRE Less than 3 mos. INSUL. THICKNESS LESS THAN $\frac{5}{64}$ INCH 2 to 5 inches held 2 min. Return 2.5 inches 2 to 6 inches before rupture 500 lbs. tensile OLD WIRE 3 mos. and over 2 to 4 inches held 2 min. Return 2.5 inches 2 to 5 inches before rupture 500 lbs. tensile INSUL. THICKNESS $\frac{5}{64}$ INCH AND OVER 2 to 4 inches held 2 min. Return 2.5 inches 2 to 5 inches before rupture 500 lbs. tensile Stretch at rate 12 inches per minute Test made at Temp. between 60°-90° F.
Electrical Test	Thickness of insulation, voltage tests and minimum insulation resistance to be in accordance with the following tables. Insulation figures are after one minute electrification and at 60° F. Tests to be made after not less than 12 hours immersion and while still immersed.

Size American Wire Gauge (B. & S.)	Insulating Wall in Accordance with Requirements of the National Board of Fire Underwriters	Insulation Resistance in Megohms at 60° F. Per Mile	Voltage Test for One Minute
14	$\frac{3}{64}$	300	1500
12	$\frac{3}{64}$	250	1500
10	$\frac{3}{64}$	225	1500
8	$\frac{3}{64}$	200	1500
6	$\frac{1}{16}$	200	2000
4	$\frac{1}{16}$	150	2000
2	$\frac{1}{16}$	125	2000
1	$\frac{5}{64}$	150	2500
0	$\frac{5}{64}$	125	2500
00	$\frac{5}{64}$	125	2500
000	$\frac{5}{64}$	100	2500
0000	$\frac{5}{64}$	100	2500
225,000 C.M.	$\frac{3}{32}$	100	3000
300,000 C.M.	$\frac{3}{32}$	100	3000
400,000 C.M.	$\frac{3}{32}$	100	3000
500,000 C.M.	$\frac{3}{32}$	100	3000
600,000 C.M.	$\frac{7}{64}$	100	3500
700,000 C.M.	$\frac{7}{64}$	100	3500
800,000 C.M.	$\frac{7}{64}$	100	3500
900,000 C.M.	$\frac{7}{64}$	100	3500
1,000,000 C.M.	$\frac{7}{64}$	100	3500
1,250,000 C.M.	$\frac{1}{8}$	100	3500
1,500,000 C.M.	$\frac{1}{8}$	75	3500
1,750,000 C.M.	$\frac{1}{8}$	60	3500
2,000,000 C.M.	$\frac{1}{8}$	50	3500

## Americore Rubber Covered Wire

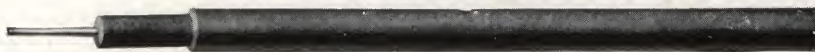
This wire is made to comply with the National Electric Code requirements and every coil is regularly examined and labeled under the supervision of Underwriters' Laboratories. A strictly high grade wire for interior wiring.

### Insulation Thickness

#### Voltage

SIZE	600	1,500	2,500	3,500	5,000	7,000
14 to 8	3-64	6-64	8-64	10-64	12-64	16-64
7 to 2	4-64	7-64	9-64	10-65	12-64	16-64
1 to 4/0	5-64	8-64	10-64	10-64	12-64	16-64
250,000 to 500,000 CM.	6-64	9-64	10-64	11-64	12-64	16-64
525,000 to 1,000,000 CM.	7-64	10-64	10-64	12-64	12-64	16-64
Larger than 1,000,000 CM.	8-64	10-64	10-64	12-64	14-64	18-64

## Americore Wires



Solid Tinned Copper Conductor

### National Electrical Code Standard

For Low Potential—0-600 Volts

American Wire Gauge (B. & S.)	Thickness of Rubber Inches	Approx. Diam. Over		List Numbers *		Weight per 1000 Ft.		Standard Packages Approx. Quantities Feet	Shipped on Reel No.
		Single Braid Inches	Double Braid Inches	Sin. Braid Blk. Finish Type Letter R. S.	Double Braid Blk. Finish Type Letter R. D.	Single Braid	Double Braid		
0000	5-64	44-64	47-64	810C	850C	...	...	....	...
000	5-64	40-64	43-64	810B	850B	...	...	....	...
00	5-64	37-64	40-64	810A	850A	...	...	....	...
0	5-64	34-64	37-64	810	850	...	...	....	...
1	5-64	32-64	35-64	811	851	...	...	....	...
2	4-64	28-64	31-64	812	852	261	271	1000	465
3	4-64	26-64	29-64	813	853	214	223	1000	465
4	4-64	24-64	27-64	814	854	177	186	1000	465
5	4-64	23-64	26-64	815	855	146	152	1000	465
6	4-64	21-64	24-64	816	856	122	128	500	Coils
8	3-64	17-64	20-64	818	858	77	83	500	Coils
10	3-64	15-64	18-64	820	860	53	58	500	Coils
12	3-64	14-64	17-64	822	862	39	44	500	Coils
14	3-64	13-64	16-64	824	864	29	33	500	Coils
16	2-64	10-64	13-64	826	866	17	20	1000	Coils
18	2-64	9-64	12-64	828	868	13	16	1000	Coils

\*White finish wire takes same list numbers as black, with suffix W added.

**Specifications:** Solid tinned annealed copper wire of highest conductivity, insulated with code thickness of high grade vulcanized rubber, protected with one or two smooth, closely woven, strong and elastic cotton braids, saturated in black weatherproof compound for outside, or white for inside use; special finish for unlined conduit work

Sizes No. 16 and No. 18 A. W. S. are not National Electric Code Standard. No. 6 A. W. G. and coarser, single braid are not National Electric Code Standard.

## Americore Cables



**Stranded Tinned Copper Conductor  
National Electrical Code Standard  
For Low Potential, 0-600 Volts**

American Wire Gauge (B. & S.)	Number and Size of Wires in Strand Inches	Thickness of Rubber Inches	Approx. Diameter Over		List Number*		Weight per 1000 Ft.		Standard Packages Approx. Quantities Feet	Shipped on Reel No.
			Single Braid Inches	Double Braid Inches	Single Braid Blk. Finish Type Letter R. S.	Double Braid Blk. Finish Type Letter R. D.	Single Braid	Double Braid		
0000	19x.1055	5-64	49-64	52-64	557	867	...	837	1000	466
000	19x.0940	5-64	45-64	48-64	558	868A	...	681	1000	466
00	19x.0836	5-64	41-64	44-64	559	869	...	556	1000	466
0	19x.0746	5-64	38-64	41-64	560	870	...	449	1000	466
1	19x.0663	5-64	35-64	38-64	561	871	...	370	1000	465
2	7x.0973	4-64	30-64	33-64	562	872	279	289	1000	465
3	7x.0867	4-64	28-64	31-64	563	873	229	239	1000	465
4	7x.0772	4-64	26-64	29-64	564	874	189	198	1000	465
6	7x.0612	4-64	23-64	26-64	566	876	130	136	500	Coils
8	7x.0485	3-64	18-64	21-64	568	878	82	88	500	Coils
10	7x.0385	3-64	16-64	19-64	570	880	59	64	500	Coils
12	7x.0305	3-64	15-64	18-64	572	882	43	47	500	Coils
14	7x.0242	3-64	14-64	17-64	574	884	32	36	500	Coils

\*White finish wire takes same list numbers as black, with suffix W added.

**Specifications:** Tinned annealed copper strand of highest conductivity, insulated with code thickness of high grade vulcanized rubber, protected with one or two smooth closely woven cotton braids saturated in black weatherproof compound for outside and white for inside use; special finish for unlined conduit work. Size No. 6 A. W. G. and coarser, single braid, are not National Electric Code Standard.

## Americore Feeder Cables



**Stranded Tinned Copper Conductor, Insulated, Tape and Braid, or Double Braid, Black Finish  
National Electrical Code Standard  
For Electric Lighting Mains, Street Railway Feeders and Power Transmission Lines**

Circular Mills	Number and Diameter of Wires in Strand Inches	For 600 Volts (Type Letter R. D.)			Weight per 1000 Ft.	Standard Packages Approx. Quantities Feet	Shipped on Reel No.
		Thickness of Rubber Inches	Approximate Diameter Over Tape and Braid, Inches	List No. Sin. Braid Over Tape			
250,000	37x.0822	3-32	56-64	340	1006	1000	467
300,000	37x.0901	3-32	59-64	341	1182	1000	467
350,000	37x.0973	3-32	62-64	342	1355	1000	467
400,000	37x.1040	3-32	64-64	343	1533	1000	467
450,000	37x.1103	3-32	65-64	344	1706	1000	467
500,000	37x.1162	3-32	72-64	345	1875	1000	467
600,000	61x.0992	7-64	79-64	346	2263	1000	467
750,000	61x.1109	7-64	86-64	347	2774	1000	468
1,000,000	61x.1280	7-64	96-64	348	3627	1000	468
1,250,000	91x.1172	8-64	107-64	348A	4546	1000	469
1,500,000	91x.1284	8-64	115-64	349	5383	500	468
2,000,000	127x.1255	8-64	129-64	349A	7066	500	468

**Specifications:** Tinned annealed copper strands of highest conductivity, insulated with code thickness of high grade vulcanized rubber, for required voltage, protected with tape and with one or two smooth closely woven cotton braids, as required, saturated in black weatherproof compound.

## Americore Rubber Covered Switchboard Cables



Flexible Tinned Copper Conductor, Black Finish

National Electrical Code Standard

For Low Potential, 0-600 Volts

American Wire Gauge (B. & S.)	Number and Diameter of Wires in Strands Inches	Thickness of Rubber Inches	Approximate Diam. Over		List Number		Standard Packages Approximate Quantities Feet	Shipped on
			Single Braid Inches	Double Braid Inches	Single Braid	Double Braid		
1	259x.018	5-64	37-64	40-64	221	271	1000	Reels
2	133x.0249	4-64	33-64	36-64	222	272	1000	Reels
3	133x.0199	4-64	30-64	33-64	223	273	1000	Reels
4	133x.0177	4-64	27-64	30-64	224	274	1000	Reels
6	49x.0231	4-64	23-64	26-64	226A	276A	1000	Reels
8	49x.0184	3-64	19-64	22-64	228	278	500	Coils
10	19x.0233	3-64	17-64	20-64	230	280	500	Coils
12	19x.0185	3-64	15-64	18-64	232	282	500	Coils
14	19x.0147	3-64	14-64	17-64	234	284	500	Coils

**Specifications:** Tinned annealed extra flexible strand of highest conductivity, insulated with code thickness of high grade vulcanized rubber, protected with one or two smooth closely woven cotton braids, saturated in black weatherproof compound and smoothly finished. The above are for switchboard, brush holder and similar connections where very flexible cables are required.

For other constructions and to determine classification see pages 77 to 80, inclusive.

## Americore Twin Wires and Cables



Solid or Stranded Tinned Copper Conductors

National Electrical Code Standard

Two Conductors Laid Parallel with Braid Over All

For Low Potential, 0-600 Volts. (Type Letter R.D.)

American Wire Gauge (B. & S.)	Thickness of Rubber Inches	Approximate Diameters Over Single Braid		List Number		Weight per 1000 Feet		Standard Packages Approx. Quantities Feet	Shipped on
		Solid, Inches	Strand, Inches	Solid	Strand	Solid	Stranded		
0000	5-64	47-64x90-64	52-64x99-64	...	687	...	1704	1000	Reels
000	5-64	44-64x80-64	48-64x92-64	...	688	...	1389	1000	Reels
00	5-64	40-64x75-64	44-64x83-64	...	689	...	1136	1000	Reels
0	5-64	37-64x70-64	40-64x77-64	...	690	...	923	1000	Reels
1	5-64	34-64x65-64	38-64x71-64	...	691	...	759	1000	Reels
2	4-64	30-64x57-64	33-64x59-64	922	692	554	600	1000	Reels
4	4-64	27-64x49-64	29-64x52-64	924	694	378	410	1000	Reels
6	4-64	23-64x44-64	24-64x45-64	926	696	262	286	1000	Reels
*8	3-64	19-64x36-64	20-64x38-64	928	698	159	174	500	Coils
*10	3-64	17-64x32-64	18-64x34-64	930	700	110	125	500	Coils
*12	3-64	16-64x29-64	17-64x31-64	932	702	82	92	500	Coils
*14	3-64	15-64x27-64	15-64x28-64	934	704	62	71	500	Coils

**Specifications:** Tinned annealed copper wires or strands of highest conductivity, each conductor insulated with code thickness of high grade vulcanized rubber, protected by saturated braid; two such finished conductors laid parallel and covered with a heavy cotton braid over all saturated in black weatherproof compound. Special finish for conduit work. The underwriters' rules permit the use of the above in sizes No. 14 and larger. No. 6 and larger shipped on reels containing approximately 1000-foot lengths, smaller sizes shipped in coils containing approximately 500-foot lengths.

\*Underwriters' rules specify that sizes 8, 10, 12 and 14 solid have one conductor with white braid. The other conductor with braid three quarters white and one quarter black, covered over all with a paraffin braid finished with black wax.

# Americore Car Cables



## N. E. Code Standard

Stranded Tinned Copper Conductor, Rubber Insulation, Single Braid Black Finish  
For Low Potential, 0-600 Volts

American Wire Gauge (B. & S.)	Number and Diameter of Wires in Strand Inches	Thickness of Rubber Inches	Approximate Diameter Over Braid Inches	List Number	Standard Packages Approximate Quantities Feet	Shipped on
2	19x.0592	4-64	31-64	2502	1000	Reels
3	19x.0526	4-64	29-64	2503	1000	Reels
4	49x.0290	4-64	29-64	2504	1000	Reels
4	7x.0772	4-64	27-64	2504A	1000	Reels
6	49x.023	4-64	25-64	2506	500	Coils
6	7x.0612	4-64	24-64	2506A	500	Coils
8	7x.0485	3-64	20-64	2508	500	Coils
10	7x.0385	3-64	18-64	2510	500	Coils
12	7x.0305	3-64	17-64	2512	500	Coils
14	7x.0242	3-64	16-64	2514	500	Coils

*Specifications:* Car cables consist of tinned annealed copper strand of highest conductivity, over which is placed a wind of fine cotton or paper and a code thickness of vulcanized rubber insulation. This is protected by a closely woven cotton braid, thoroughly saturated with black weatherproof compound and finished smooth.

This cable is used for both power and light circuits in electric cars and motor lead cables. It differs from the other rubber insulated conductors already described, in having a layer of fine cotton or paper wound on the conductor underneath the rubber which is easily removed and which leaves the conductor clean for jointing.

# Americore Fireproof Cables



Stranded Tinned Copper Conductor, Double Braid White Finish  
For High Potential, Exposed Arc Lighting and Station Wiring  
Order by List Numbers

American Wire Gauge (B. & S.)	Number and Diameter of Wires in Strand, Inches	For $\frac{3}{32}$ -Inch Rubber		For $\frac{1}{8}$ -Inch Rubber		Shipped on
		Approximate Diameter Over Braid Inches	List Number	Approximate Diameter Over Braid Inches	List Number	
0000	19x.1055	59-64	887	63-64	987	Reels
000	19x.0940	55-64	888	59-64	988	Reels
00	19x.0836	52-64	889	56-64	989	Reels
0	19x.0746	49-64	890	53-64	990	Reels
1	19x.0663	46-64	891	50-64	991	Reels
2	7x.0973	42-64	892	47-64	992	Reels
4	7x.0772	39-64	894	43-64	994	Reels
6	7x.0612	35-64	896	39-64	996	Reels
8	7x.0485	33-64	898	37-64	998	Reels

*Specifications:* Tinned annealed copper strand of highest conductivity, insulated with required thickness of high grade vulcanized rubber, protected with two smooth, closely woven strong heavy cotton braids, each of which is thoroughly saturated in white flame-proof compound, smoothly finished. See note below.

This wire is placed before the public at the suggestion of many superintendents of electric light companies who are using it for wiring their stations. It is fireproof in the sense that the braid will not ignite or carry flame.

Shipped on reel containing approximately 1000-foot lengths.

NOTE.— We can furnish any style or size of rubber-covered wire, covered with one, two or any number of braids, saturated in fire-proof compound, smoothly finished. High voltage cables for interior service, as in switchboard or station work, if protected by heavy braids, thoroughly flame-proofed, give exceptionally good protection where the reduction of fire risk is essential. This fire-resisting covering possesses good mechanical and moisture-proof qualities, and is capable of localizing the effects of burnout or external combustions.

**Americore Mining Machine Cables**

For Low Potential, 0-600 Volts

**Twin Mining Machine Cable****Concentric Mining Machine Cable**

These cables are ordinarily furnished in three general constructions and in a variety of finishes. Twin, Duplex Concentric Style A, and Duplex Concentric Style B with the following finishes, namely:

Two Regular Cotton Braids.

Three Regular Cotton Braids.

One Regular Cotton and One Corded Cotton Braids.

Two Regular Cotton and One Corded Cotton Braids.

One Regular Cotton Braid and One Tubular Weave.

All are furnished with heavy weatherproof finish.

Twin Mining Machine Cable consists of two flexible conductors of tinned annealed copper, each of which is insulated with code thickness (600 volts) of Americore rubber and protected with a cotton braid saturated with weatherproof compound. The two insulated and braided conductors are laid parallel and covered with any one of the five finishes listed above.

Duplex Concentric Mining Machine Cable Style A has an inner tinned copper conductor of flexible construction insulated with code thickness (600 volts) of Americore rubber and covered with a tape. Over this core is stranded the outer conductor consisting of a number of tinned annealed copper wires, equal in area to the central conductor. This layer of wires is insulated with code thickness (600 volts) of Americore rubber and covered with any one of the five finishes listed above.

Duplex Concentric Mining Machine Cable Style B is constructed the same as Style A, except that that there is no supplementary belt of rubber over the outer conductor.

Other details of construction, such as number of wires, outside diameters, etc., are shown in the following tables.

**Americore Twin Mining Machine Cables—600 Volts**

Size American Wire Gauge (B. & S.)	No. of Wires	Out. Dia.	Weight per 1000 Feet	FINISH	Packing	
					No. Feet	Reel No.
2	133	.577x1.070	665	Two Regular Braids.....	1000	467
3	133	.541x .998	556	Two Regular Braids.....	1000	467
4	133	.503x .928	461	Two Regular Braids.....	1000	466
5	49	.469x .860	385	Two Regular Braids.....	1000	466
6	49	.444x .810	328	Two Regular Braids.....	1000	466
8	49	.365x .658	211	Two Regular Braids.....	1000	466
2	133	.619x1.112	703	Three Regular Braids.....	1000	467
3	133	.583x1.040	593	Three Regular Braids.....	1000	467
4	133	.545x .970	498	Three Regular Braids.....	1000	466
5	49	.511x .902	417	Three Regular Braids.....	1000	466
6	49	.486x .852	359	Three Regular Braids.....	1000	466
8	49	.401x .694	236	Three Regular Braids.....	1000	466
2	133	.620x1.113	693	One Reg. & One Corded Braid.....	1000	467
3	133	.584x1.041	584	One Reg. & One Corded Braid.....	1000	467
4	133	.552x .977	495	One Reg. & One Corded Braid.....	1000	466
5	49	.518x .909	415	One Reg. & One Corded Braid.....	1000	466
6	49	.493x .859	353	One Reg. & One Corded Braid.....	1000	466
8	49	.414x .707	237	One Reg. & One Corded Braid.....	1000	466
2	133	.662x1.155	736	Two Reg. & One Corded Braid.....	1000	467
3	133	.626x1.083	624	Two Reg. & One Corded Braid.....	1000	467
4	133	.594x1.020	533	Two Reg. & One Corded Braid.....	1000	466
5	49	.560x .951	454	Two Reg. & One Corded Braid.....	1000	466
6	49	.535x .901	395	Two Reg. & One Corded Braid.....	1000	466
8	49	.450x .743	265	Two Reg. & One Corded Braid.....	1000	466
2	133	.675x1.168	712	One Reg. & One Tub. Weave.....	1000	467
3	133	.639x1.096	600	One Reg. & One Tub. Weave.....	1000	467
4	133	.607x1.032	509	One Reg. & One Tub. Weave.....	1000	467
5	49	.573x .964	431	One Reg. & One Tub. Weave.....	1000	466
6	49	.548x .914	371	One Reg. & One Tub. Weave.....	1000	466
8	49	.469x .762	247	One Reg. & One Tub. Weave.....	1000	466

## Americore Concentric Mining Machine Cables

### Style A—600 Volts

A. S. & W. Co.'s Steel Wire Gauge (B. & S.)	No. of Wires	Out. Dia.	Weight per 1000 Feet	FINISH	Packing	
					No. Feet	Reel No.
2	133	.772	681	Two Regular Braids	1000	466
3	133	.726	572	Two Regular Braids	1000	466
4	133	.686	478	Two Regular Braids	1000	466
5	49	.645	402	Two Regular Braids	1000	466
6	49	.601	334	Two Regular Braids	1000	466
8	49	.486	215	Two Regular Braids	1000	466
2	133	.808	712	Three Regular Braids	1000	466
3	133	.762	598	Three Regular Braids	1000	466
4	133	.722	500	Three Regular Braids	1000	466
5	49	.681	423	Three Regular Braids	1000	466
6	49	.634	352	Three Regular Braids	1000	466
8	49	.519	225	Three Regular Braids	1000	466
2	133	.815	706	One Reg. & One Corded Braid	1000	467
3	133	.769	592	One Reg. & One Corded Braid	1000	466
4	133	.729	497	One Reg. & One Corded Braid	1000	466
5	49	.688	424	One Reg. & One Corded Braid	1000	466
6	49	.653	361	One Reg. & One Corded Braid	1000	466
8	49	.538	232	One Reg. & One Corded Braid	1000	466
2	133	.851	741	Two Reg. & One Corded Braid	1000	467
3	133	.805	627	Two Reg. & One Corded Braid	1000	466
4	133	.765	522	Two Reg. & One Corded Braid	1000	466
5	49	.724	447	Two Reg. & One Corded Braid	1000	466
6	49	.686	378	Two Reg. & One Corded Braid	1000	466
8	49	.571	251	Two Reg. & One Corded Braid	1000	466
2	133	.870	709	One Reg. & One Tub. Weave	1000	467
3	133	.824	597	One Reg. & One Tub. Weave	1000	467
4	133	.784	504	One Reg. & One Tub. Weave	1000	466
5	49	.743	429	One Reg. & One Tub. Weave	1000	466
6	49	.708	368	One Reg. & One Tub. Weave	1000	466
8	49	.593	251	One Reg. & One Tub. Weave	1000	466

### Style B—600 Volts

2	133	.647	549	Two Regular Braids	1000	466
3	133	.589	444	Two Regular Braids	1000	466
4	133	.549	364	Two Regular Braids	1000	466
5	49	.508	299	Two Regular Braids	1000	466
6	49	.476	247	Two Regular Braids	1000	466
8	49	.392	152	Two Regular Braids	1000	465
2	133	.683	570	Three Regular Braids	1000	466
3	133	.622	460	Three Regular Braids	1000	466
4	133	.582	378	Three Regular Braids	1000	466
5	49	.541	313	Three Regular Braids	1000	466
6	49	.509	259	Three Regular Braids	1000	466
8	49	.425	163	Three Regular Braids	1000	465
2	133	.690	572	One Reg. & One Corded Braid	1000	466
3	133	.641	468	One Reg. & One Corded Braid	1000	466
4	133	.601	389	One Reg. & One Corded Braid	1000	466
5	49	.560	321	One Reg. & One Corded Braid	1000	466
6	49	.528	270	One Reg. & One Corded Braid	1000	466
8	49	.444	184	One Reg. & One Corded Braid	1000	466
2	133	.726	595	Two Reg. & One Corded Braid	1000	466
3	133	.674	485	Two Reg. & One Corded Braid	1000	466
4	133	.634	405	Two Reg. & One Corded Braid	1000	466
5	49	.593	336	Two Reg. & One Corded Braid	1000	466
6	49	.561	285	Two Reg. & One Corded Braid	1000	466
8	49	.477	197	Two Reg. & One Corded Braid	1000	466
2	133	.745	590	One Reg. & One Tub. Weave	1000	466
3	133	.696	475	One Reg. & One Tub. Weave	1000	466
4	133	.656	393	One Reg. & One Tub. Weave	1000	466
5	49	.615	327	One Reg. & One Tub. Weave	1000	466
6	49	.583	275	One Reg. & One Tub. Weave	1000	466
8	49	.499	192	One Reg. & One Tub. Weave	1000	466

## Americore Locomotive Gathering Cables

These cables consist of a single flexible conductor of tinned annealed copper, insulated with code thickness (600 volts) of Americore rubber and covered with a braided finish as follows: two regular cotton braids; one regular and one corded cotton braids; one skeleton and one corded braid; and one regular cotton braid with one tubular weave. All are furnished with heavy weatherproof finish.

Size American Wire Gauge (B. & S.)	No. of Wires	FINISH	Out. Dia.	Wgt. per 1,000 Feet	Packing	
					Feet	Reel No.
2	133	Two Regular Braids .....	.526	312	1000	422
3	133	Two Regular Braids .....	.490	259	1000	465
4	133	Two Regular Braids .....	.458	214	1000	465
5	49	Two Regular Braids .....	.424	179	1000	465
6	49	Two Regular Braids .....	.399	151	1000	465
2	133	One Reg. & One Corded Braid .....	.578	330	1000	422
3	133	One Reg. & One Corded Braid .....	.542	275	1000	422
4	133	One Reg. & One Corded Braid .....	.510	231	1000	422
5	49	One Reg. & One Corded Braid .....	.476	195	1000	465
6	49	One Reg. & One Corded Braid .....	.451	165	1000	465
2	133	One Reg. & One Tub. Weave .....	.633	342	1000	466
3	133	One Reg. & One Tub. Weave .....	.597	287	1000	422
4	133	One Reg. & One Tub. Weave .....	.565	242	1000	422
5	49	One Reg. & One Tub. Weave .....	.531	205	1000	422
6	49	One Reg. & One Tub. Weave .....	.506	180	1000	422
2	133	One Skeleton & One Corded Braid .....	.628	365	1000	466
3	133	One Skeleton & One Corded Braid .....	.592	303	1000	422
4	133	One Skeleton & One Corded Braid .....	.560	243	1000	422

## Americore Fixture Wire

### Light Insulation

#### Solid Tinned Copper Conductor, Rubber Insulation, Single Braid Black Finish

American Wire Gauge (B. & S.)	Thickness of Rubber Inches	Approximate Diameter Over Braid Inches	List Number	Weight per 1000 Ft.	Standard Coils Approximate Quantities Feet
16	1-64	6-64	8006	13	1000
*18	1-64	5-64	8008	9	1000
20	1-64	5-64	....	7	1000

**Specifications:** Solid tinned annealed copper wire of highest conductivity, insulated with  $\frac{1}{64}$ -inch vulcanized rubber, covered with single braid of cotton, saturated in black weatherproof compound and smoothly polished. May also be furnished with Stranded Conductor if desired.

Used only in arms of fixtures not exceeding 24 inches in length and to supply not more than one 16 candle-power lamp.

\*Size 18 only approved by the Underwriters.

Americore Theatre or Stage Cables



In sizes No. 10 to No. 20 inclusive, each conductor is regular lamp cord strand, cotton wound, insulated with code thickness of vulcanized rubber, protected with a cotton braid saturated with weatherproof compound.

Two or three such conductors are then twisted together, the interstices of which are filled with jute laterals to make the whole cylindrical, over which is then placed two heavy cotton braids saturated with a weatherproof compound, wax polish finish.

In sizes No. 8 to No. 2 the construction corresponds exactly to the above except that the bare conductors consist of concentric strands of tinned copper wires. Number of wires used in each size shown by the following table.

American Wire Gauge (B. & S.)	Number of Wires in Strand	List Number	Weight per 1000 Feet Pounds	American Wire Gauge (B. & S.)	Number of Wires in Strand	List Number	Weight per 1000 Feet Pounds
2	210	8972*	903	12	65	8982L	159
4	133	8974	636	14	41	8984L	123
6	49	8976	462	16	26	8986L	72
8	49	8978	287	18	16	8988L	60
10	104	8980L	202	20	10	8990L	52

List numbers given cover two conductor cable.

\*Underwriters do not approve this size.

Border Light Cables

The construction of these cables is the same as that of Theatre and Stage Cables (see above), but has not jute fillers and may have more than three conductors.

Americore Deck Cables

Each conductor made up of a seven tinned copper wire strand insulated with code thickness of vulcanized rubber and covered with a cotton braid. Two such conductors are then twisted into pairs (the interstices of which are filled with jute laterals to make the whole cylindrical), over which is placed a supplementary layer of vulcanized rubber  $\frac{1}{32}$  inch thick, then braided over all with one cotton braid saturated with weatherproof compound, wax polish finish.

American Wire Gauge (B. & S.)	List Number	American Wire Gauge (B. & S.)	List Number
10	9960	16	9966
12	9962	18	9968
14	9964	..	....

## Single Conductor, Twisted Pair, and Triple Conductor Inside or Sub-station Wire



Conductors, No. 19 American Wire Gauge (B. & S.), soft drawn tinned copper insulated to a diameter of  $\frac{3}{32}$  of an inch over rubber, covered with a single hard glazed cotton braid. Single conductors are braided with plain colored cotton, while in the twisted pair one conductor contains a differently colored tracer thread and in triple conductor two of the three wires contain different colors or different design of tracer threads, thus making no two of the conductor braids alike. Sometimes a differently colored cotton braid is used, one for each conductor for purposes of distinction.

## Pot Head Wires, Plain Conductors



Furnished in the smaller sizes, 18, 19 or 20 American Wire Gauge (B. & S.) either single conductor or twisted pair. Soft tinned copper conductors insulated to a diameter of  $\frac{3}{32}$  of an inch over rubber without any outer braid or protection. In case of twisted pairs, one conductor is sometimes made of a differently colored rubber than the other so as to discriminate between them.

The following table includes the foregoing telephone wires and others not otherwise described. Any of the sizes can be furnished in single or multiple conductors.



## Telephone Wires, Twisted Pairs

American Wire Gauge (B. & S.)	Finish	Diameter Over Rubber Inches	List Numbers			Approximate Weight per 1000 Feet
			No Test	100 Megohms	Over 100 Megohms	
14	Weatherproof Braided	11-64	9141	9040	9040A	65
14	Weatherproof Braided	5-32	9145	9045	9045A	59
16	Weatherproof Braided	5-32	9165	9065	9065A	51
16	Weatherproof Braided	9-64	9169	9069	9069A	46
16	Weatherproof Braided	4-32	9164	9064	9064A	40
18	Weatherproof Braided	4-32	9184	9084	9084A	36
18	Weatherproof Braided	7-64	9187	9087	9087A	31
19	Hard Cotton Braided	7-64	9197	9097	9097A	23
19	Hard Cotton Braided	3-32	9193	9093	9093A	19
20	Hard Cotton Braided	3-32	9120	9020	9020A	18
19	Plain	3-32	9193P	9093P	9093B	16
20	Plain	3-32	9120P	9020P	9020B	15

List numbers cover the finishes shown; other finishes can be furnished when desired.

## Telephone Cables

These are made to include any number of single conductors or twisted pairs of insulated telephone wires either plain or braided, bunched together or laid up concentrically with a tape or cotton braid or other fibrous covering over all. They are frequently encased in a lead sheath or armored. These cables vary greatly in construction and are furnished to buyers' requirements and specifications. Used chiefly by municipalities for underground telegraph and fire-alarm service.

## Bridle or Spider Wire

This wire is ordinarily used for short runs from the building terminal to the arrester or for terminal pole wiring between the aerial and underground cable terminals.

The term Spider Wire is generally applied to single conductor and Bridle Wire to twisted pair.

No. 18 A. W. G. (B. & S.) soft drawn tinned copper wire, insulated to a diameter of  $\frac{7}{64}$  inch over rubber and covered with a cotton braid, saturated with black weatherproof compound, wax finish.

When furnished in twisted pairs, one conductor has a raised tracer in the braid to distinguish it from the other conductor.

## Drop Wire

No. 14 American Wire Gauge (B. & S.) twisted pair,  $\frac{5}{32}$  inch over insulation with black saturated weatherproof braid and raised marker in one conductor. Hard drawn copper.

This service involves the drop from the pole terminal to the house bracket. No. 16 American Wire Gauge (B. & S.) insulated to  $\frac{3}{32}$  inch is extensively used but on account of the severe service to which this type of wire is put, necessitating great resistance to climatic conditions, No. 14 American Wire Gauge (B. & S.) is considered the standard because of its increased tensile strength.

## Jumper Wire

This is often confused with Spider and Bridle wires in outside construction, but by the more general acceptance of the term, it applies to the wire used for cross-connecting service on the main distributing frame. It is usually a No. 20 American Wire Gauge (B. & S.) wire insulated to  $\frac{3}{32}$  inch with flame-proof braids; if twisted pair, one is red and one white.

## Rubber Covered Iron Telephone Wire, Single Conductor



These conductors are generally No. 12 or No. 14 American Wire Gauge (B. & S.) galvanized iron wire insulated with code thickness of vulcanized rubber, either single or double cotton braid, weatherproof saturated and wax polished.

American Wire Gauge (B. & S.)	Thickness Rubber Inches	Single Braid		Double Braid	
		List Number	Approximate Weight per 1000 Feet	List Number	Approximate Weight per 1000 Feet
12	$\frac{3}{64}$	1512	100	1512A	140
14	$\frac{3}{64}$	1514	75	1514A	100

When furnished in twisted pairs, one conductor contains a raised tracer thread to distinguish it from the other conductor.

# American Ignition Lighting and Starting Wires and Cables

**For Automobiles, Motor Boats and Airplanes**

**A separate Ignition Wires and Cables catalogue is issued.   Furnished on request**



Plain Rubber Covered Primary and Secondary cables made in 5, 7 and 9 mm. outside diameter. All size 14. American Wire Gauge; Style RR.



Braided and rubber insulated primary and lighting cables in sizes 16, 14, 12 and 10. American Wire Gauge; Style RS1W.



Braided and cambric insulated primary and lighting cables in sizes 16, 14, 12 and 10. American Wire Gauge; Style C1W.



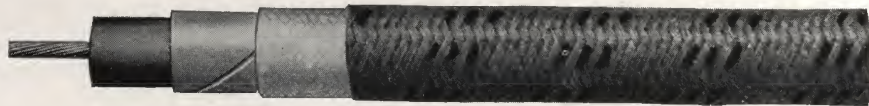
Armored, braided and cambric insulated lighting cables, single or twin conductors, in sizes 18, 16, 14, 12 or 10 American Wire Gauge. Styles GA and GA2W.



Single braided and rubber insulated light secondary cable size 14 American Wire gauge; Style FS.



Double braided rubber insulated medium secondary cable, size 14 American Wire gauge; Style RB9.



Double braided, cambric and rubber insulated secondary cable, size 14 American Wire Gauge; Style B9.



Plain high grade rubber covered battery cable, in sizes 1, 2, 4, 6 and 8 American Wire Gauge; Style PB.



Cambric insulated starter cables in sizes 1-0, 1, 2, 3 and 4 American Wire Gauge; Style CS.



Americore rubber insulated starter cables, in sizes 2-0, 1-0, 1, 2, 3 and 4 American Wire Gauge; Style ARS.

# Rubber-Clad Cords and Cables

Cords and Cables of this construction are designed for use where the conditions of operation are most severe. They are practically proof against the deteriorating effects of oils, acids, etc., and their light weight and smooth, clean outer surface prevents them from accumulating grease and dirt and makes them easy to handle.

Manufactured as Portable Cords, Locomotive Gathering Cables, Mining Machine and Welding Cables.

The Portable Cord constructions are made with regular lamp cord strand conductor, cotton wound, insulated with high grade 30% rubber compound—two or three such conductors, as desired, are twisted together and covered with 60% rubber compound (no braid is applied on the outside.)

Locomotive Gathering and Welding Machine Cables are of the single conductor type. To give tensile strength to the Locomotive Cables, the conductor is made with a steel reinforced center. Seven tinned steel wires are assembled, around which are laid twelve tinned copper wires, forming a core, around this core are laid seven strands (seven wires to the strand) of tinned copper to the desired capacity, and finish of 40% and 60% rubber compound completes the assembly.

Mining Machine Cables are laid up along the same general lines as Portable Cords and Locomotive Cables. The standard constructions being the same as for braided Mining Machine Cables, viz: two-conductor round, three-conductor, and duplex concentric.

For full details refer to following tables:



Two Conductor Portable Cord



Duplex Concentric Mining Machine Cable

## Rubber-Clad Portable Cords

Size American Wire Gauge (B. & S.)	Weight per 1,000 feet	PACKING		Approximate Outside Diameter
		Feet	Coils	
Two Conductor				
10	269	500	Coils	.640
12	208	500	Coils	.578
14	168	500	Coils	.531
16	105	500	Coils	.422
18	86	500	Coils	.391
Three Conductor				
10	327	500	Coils	.688
12	248	500	Coils	.609
14	201	500	Coils	.563
16	128	500	Coils	.455
18	98	500	Coils	.406

## Rubber-Clad Welding and Locomotive Gathering Cables

Size American Wire Gauge (B. & S.)	Number of Wires	Weight per 1,000 Feet	PACKING		Outside Diameter Inches	Tare Weight per 1,000 Feet
			Feet	Reel No.		
Welding Machine Cables (Single Conductor)						
2-0	259	675	1,000	467	.813	336
1-0	259	569	1,000	466	.763	127
1	259	484	1,000	466	.722	127
2	259	385	1,000	466	.649	127
3	259	327	1,000	466	.613	127
4	259	279	1,000	466	.580	127
Locomotive Gathering Cables						
2	133	404	1,000	466	.680	127
*2	See	411	1,000	466	.683	127
*3	Below	348	1,000	466	.648	127
*4	*	292	1,000	466	.606	127

Standard Construction (with Steel Reinforced Conductor).

No. 2 A. W. Ga.:—Seven tinned steel Monitor wires, each .027 inch, around which are laid twelve tinned copper wires each .027 inch forming a core. Around this core are laid seven strands (seven wires to the strand, each .034 inch) of tinned copper.

No. 3 A. W. Ga.:—Seven tinned steel Monitor wires, each .0255 inch, around which are laid twelve tinned copper wires, each .0255 inch, forming a core. Around this core are laid seven strands (seven wires to the strand, each .0293 inch) of tinned copper.

No. 4 A. W. Ga.:—Seven tinned steel Monitor wires, each .021 inch, around which are laid twelve tinned copper wires, each .021 inch, forming a core. Around this core are laid seven strands (seven wires to the strand, each .0261 inch) of tinned copper.

## Rubber-Clad Mining Machine Cables

Size American Wire Gauge (B. & S.)	Number of Wires	Weight per 1,000 Feet	PACKING		Outside Diameter Inches	Tare Weight per 1,000 Feet
			Feet	Reel No.		
Two-Conductor Round						
1	133	1,227	1,000	468	1.338	465
2	133	986	1,000	468	1.192	465
3	133	844	1,000	468	1.120	465
4	133	729	1,000	468	1.056	465
5	49	629	1,000	467	.990	336
6	49	552	1,000	467	.938	336
8	49	382	1,000	466	.792	127
Three-Conductor Round						
1	133	1,597	1,000	468	1.415	465
2	133	1,267	1,000	468	1.258	465
3	133	1,076	1,000	468	1.181	465
4	133	920	1,000	468	1.112	465
5	49	786	1,000	467	1.041	336
6	49	682	1,000	467	.985	336
8	49	475	1,000	467	.832	336
Duplex Concentric						
1	133	993	1,000	467	1.027	336
2	133	816	1,000	467	.944	336
3	133	699	1,000	467	.898	336
4	133	605	1,000	467	.858	336
5	49	503	1,000	466	.787	127
6	49	440	1,000	466	.754	127
8	49	302	1,000	466	.639	127

\*Outer Conductors of Concentric Cables are made up of 37 wires.

# American Park and Suburban Cables

## Standard Forms

with either

**Steel or Non-Magnetic Metal Tape Armor Solid or  
Stranded Conductors**



**Single Conductor**



**Flat Twin or Two Conductor**



**Three Conductor**

**For Specifications see pages 44 to 48, inclusive.**

## Steel and Non-Magnetic Metal Tape Armored Cables

These cables have been designed for use without conduit or other protection, and offer all the advantages of a cable in conduit at but a small part of the cost of such a system.

They are usually laid in the ground in a shallow trench from 12 to 24 inches below the surface, the depth depending upon the location, no other protection being necessary, due to their construction, an example of which is explained below.

These cables are made with any number of conductors, of any size, either solid or stranded, and for any voltage, and may be insulated with rubber, with paper, or with cambric, as desired. The method of construction is practically the same in every case.

### Example of Construction

#### Stranded, Single Conductor, Rubber Insulated, Steel Taped, Park and Suburban Cable

Standard construction is shown on following pages.

The wires making up the copper conductor are tinned to prevent corrosion of copper by sulphur in rubber insulation and then the conductor is given an insulation of rubber of required thickness and quality.

Then a rubber filled tape is applied.

In the case of Three Conductor and Two Conductor or Duplex (round), each conductor is insulated with rubber, taped, and the conductors are then twisted together with jute fillers. Tape is then wrapped around the group. In the case of the Twin (flat) there are no jute fillers or tape over all. Twin cable is furnished when two conductors are required, unless two-conductor round cable is specified.

A lead sheath is placed over the tape to exclude moisture.

An asphalt saturated jute covering is applied over the lead sheath, acting as a cushion between the armor and lead, thus protecting the lead from mechanical injury by the steel tapes and preventing an accumulation of moisture between the lead and armor.

A steel tape armor consisting of two electro-galvanized flat steel tapes is then applied. The tapes are wound in the same direction, the outer tape overlapping the line of separation between the spirals of the inner tape, thus giving flexibility, while preventing any opening in the armor when the cable is bent, which might possibly allow an injury to the lead sheath and insulation below.

An asphalt saturated jute covering is placed outside of the steel tape armor to protect it from corrosive action of moisture or any chemicals which may be in the soil, and from electrolysis.

### Uses

Street Lighting  
Railroad Yard Lighting  
In Coal Mines  
Industrial Plants  
Park and Ground Lighting

Submarine service under lakes  
and rivers where tensile  
strength is not looked for  
Railway Signal Service  
And many others.

## Non-Magnetic Metal Tape Armored Cables

For several years past there has been a large demand for an armored cable suitable for street lighting and similar uses in which faults could be located without removing the cable from the ground. This long-felt want is found in our Non-Magnetic Metal Tape Armored cables (patent applied for).

Heretofore it has been customary to make armored street lighting cables and similar cables with flat steel tapes over the lead sheath. It has been found that in attempting to locate a fault in a steel tape armored cable by means of an alternating testing current and exploring coil, the energy of the testing current is absorbed in hysteresis and eddy current losses in the steel tape. With our non-magnetic tape the magnetic permeability is unity as in air, and faults may readily be located.

It will readily be seen that such a cable has many advantages in that its position in the ground can be easily located by the exploring coil without doing any excavating, and in the case of a short circuit in the cable the fault is easily located, and excavation is only necessary at the point of burn-out in order to make repairs. These cables are constructed the same as our steel taped cables.

These cables are not an experiment; they have been installed and tested and found to be what is claimed, i. e., the construction is such as to enable any trouble to be localized, a function not possible with a steel taped cable, and yet the non-magnetic armored cables are fully as strong with regard to mechanical protection.

The cost of these cables is but slightly more than the regular steel taped armored cables.

## Standard Specifications

### Single Conductor Americore Rubber Insulated for 600 Volts Service

Size of Conductor American Wire Gauge (B. & S.)	No. of Wires	Thickness of Insulation Inches	Thickness of Lead Covering Inches	Approx. O. D. Over Jute	Approx. Weight per 1000 ft.
No. 8	1	$\frac{3}{64}$	$\frac{3}{64}$	.705	601
6	1	$\frac{1}{16}$	$\frac{1}{16}$	.801	881
4	7	$\frac{1}{16}$	$\frac{1}{16}$	.871	1060
2	7	$\frac{1}{16}$	$\frac{1}{16}$	.930	1222
1	19	$\frac{5}{64}$	$\frac{5}{64}$	1.002	1439
1-0	19	$\frac{5}{64}$	$\frac{5}{64}$	1.043	1583
2-0	19	$\frac{5}{64}$	$\frac{5}{64}$	1.088	1753
3-0	19	$\frac{5}{64}$	$\frac{5}{64}$	1.140	1957
4-0	19	$\frac{5}{64}$	$\frac{5}{64}$	1.198	2134

### Standard Flat Twin or Two Conductor Americore Rubber Insulated for 600 Volts Service

Size of Conductor American Wire Gauge (B. & S.)	No. of Wires	Thickness of Insulation Inches	Thickness of Lead Covering Inches	Approx. O. D. Over Jute		Approx. Weight per 1000 ft.
				Max.	Min.	
No. 8	1	$\frac{3}{64}$	$\frac{3}{64}$	.952	.707	833
6	1	$\frac{1}{16}$	$\frac{1}{16}$	1.113	.802	1283
4	7	$\frac{1}{16}$	$\frac{1}{16}$	1.252	.871	1595
2	7	$\frac{1}{16}$	$\frac{1}{16}$	1.373	.932	1929
1	19	$\frac{5}{64}$	$\frac{5}{64}$	1.545	1.033	2575
1-0	19	$\frac{5}{64}$	$\frac{5}{64}$	1.629	1.075	2821
2-0	19	$\frac{5}{64}$	$\frac{5}{64}$	1.719	1.120	3122
3-0	19	$\frac{5}{64}$	$\frac{5}{64}$	1.822	1.172	3553
4-0	19	$\frac{5}{64}$	$\frac{5}{64}$	1.936	1.229	4029

### Standard Three Conductor Americore Rubber Insulated for 600 Volts Service

Size of Conductor American Wire Gauge (B. & S.)	No. of Wires	Thickness of Insulation Inches	Thickness of Lead Covering Inches	Approx. O. D. Over Jute	Approx. Weight per 1000 ft.
No. 8	1	$\frac{3}{64}$	$\frac{1}{16}$	1.045	1293
6	1	$\frac{1}{16}$	$\frac{1}{16}$	1.184	1754
4	7	$\frac{1}{16}$	$\frac{5}{64}$	1.365	2463
2	7	$\frac{1}{16}$	$\frac{5}{64}$	1.495	2991
1	19	$\frac{5}{64}$	$\frac{3}{32}$	1.681	4011
1-0	19	$\frac{5}{64}$	$\frac{3}{32}$	1.769	4465
2-0	19	$\frac{5}{64}$	$\frac{3}{32}$	1.865	5004
3-0	19	$\frac{5}{64}$	$\frac{3}{32}$	1.982	5398
4-0	19	$\frac{5}{64}$	$\frac{3}{32}$	2.133	6684

## Standard Specifications

### Single Conductor 30% Rubber Insulated for 2500 Volts Service

Size of Conductor American Wire Gauge (B. & S.)	No. of Wires	Thickness of Insulation Inches	Thickness of Lead Covering Inches	Approx. O. D. Over Jute	Approx. Weight per 1000 ft.
No. 8	1	$\frac{3}{32}$	$\frac{1}{16}$	.830	896
6	1	$\frac{3}{32}$	$\frac{1}{16}$	.864	988
4	7	$\frac{3}{32}$	$\frac{1}{16}$	.933	1169
2	7	$\frac{3}{32}$	$\frac{1}{16}$	.993	1357
1	19	$\frac{3}{32}$	$\frac{1}{16}$	1.033	1482
1-0	19	$\frac{3}{32}$	$\frac{1}{16}$	1.078	1629
2-0	19	$\frac{3}{32}$	$\frac{1}{16}$	1.120	1802
3-0	19	$\frac{3}{32}$	$\frac{1}{16}$	1.172	2008
4-0	19	$\frac{3}{32}$	$\frac{1}{16}$	1.229	2254

One covering of .012" rubber filled tape.

Covered with one serving of .075" thick two coverings of .020" metal tapes and one serving of .008" thickness of saturated jute, and compound finish.

### Standard Twin Conductor 30% Rubber Insulated for 2500 Volts Service

Size of Conductor American Wire Gauge (B. & S.)	No. of Wires	Thickness of Insulation Inches	Thickness of Lead Covering Inches	Approx. O. D. Over Jute		Approx. Weight per 1000 ft.
				Max.	Min.	
No. 8	1	$\frac{3}{32}$	$\frac{1}{16}$	1.170	.830	1256
6	1	$\frac{3}{32}$	$\frac{1}{16}$	1.238	.864	1509
4	7	$\frac{3}{32}$	$\frac{1}{16}$	1.378	.934	1835
2	7	$\frac{3}{32}$	$\frac{1}{16}$	1.529	1.025	2430
1	19	$\frac{3}{32}$	$\frac{1}{16}$	1.607	1.064	2683
1-0	19	$\frac{3}{32}$	$\frac{1}{16}$	1.691	1.106	2964
2-0	19	$\frac{3}{32}$	$\frac{1}{16}$	1.781	1.151	3298
3-0	19	$\frac{3}{32}$	$\frac{1}{16}$	1.885	1.203	3705
4-0	19	$\frac{3}{32}$	$\frac{1}{16}$	1.999	1.260	4179

Each conductor covered with one .012" thick rubber filled tape. Laid parallel.

Covered with one serving of .075" thickness of saturated jute, two coverings of .020" metal tapes and one serving of .008" thickness of saturated jute, compound finish.

### Standard Three Conductor 30% Rubber Insulated for 2500 Volts Service

Size of Conductor American Wire Gauge (B. & S.)	No. of Wires	Thickness of Insulation Inches	Thickness of Lead Covering Inches	Approx. O. D. Over Jute	Approx. Weight per 1000 ft.
No. 8	1	$\frac{3}{32}$	$\frac{5}{64}$	1.278	1977
6	1	$\frac{3}{32}$	$\frac{5}{64}$	1.381	2583
4	7	$\frac{3}{32}$	$\frac{5}{64}$	1.530	3086
2	7	$\frac{3}{32}$	$\frac{5}{64}$	1.660	3698
1	19	$\frac{3}{32}$	$\frac{5}{64}$	1.747	4101
1-0	19	$\frac{3}{32}$	$\frac{5}{64}$	1.836	4527
2-0	19	$\frac{3}{32}$	$\frac{5}{64}$	1.933	4966
3-0	19	$\frac{3}{32}$	$\frac{5}{64}$	2.076	6102
4-0	19	$\frac{3}{32}$	$\frac{5}{64}$	2.121	6872

Each conductor covered with one .012" rubber filled tape. Three conductors twisted together with saturated jute fillers and one .012" rubber filled tape over all.

Covered with one serving of .075" thickness of saturated jute, two coverings of .020" metal tapes and one serving of .008" thickness of saturated jute, compound finish.

# Standard Specifications

## Standard Single Conductor 30% Rubber Insulated for 5000 Volts Service

Size of Conductor American Wire Gauge (B. & S.)	No. of Wires	Thickness of Insulation Inches	Thickness of Lead Covering Inches	Approx. O. D. Over Jute	Approx. Weight per 1000 ft.
No. 8	1	$\frac{9}{64}$	$\frac{1}{16}$	.924	1088
6	1	$\frac{9}{64}$	$\frac{1}{16}$	.957	1183
4	7	$\frac{9}{64}$	$\frac{1}{16}$	1.027	1373
2	7	$\frac{9}{64}$	$\frac{1}{16}$	1.087	1570
1	19	$\frac{9}{64}$	$\frac{1}{16}$	1.127	1704
1-0	19	$\frac{9}{64}$	$\frac{1}{16}$	1.168	1851
2-0	19	$\frac{9}{64}$	$\frac{1}{16}$	1.213	2026
3-0	19	$\frac{9}{64}$	$\frac{1}{16}$	1.265	2237
4-0	19	$\frac{9}{64}$	$\frac{5}{64}$	1.354	2742

One covering of .012" rubber filled tape.

Covered with one serving .075" thickness of saturated jute, two coverings of .020" metal tapes and one serving .068" thickness of saturated jute compound finish.

## Standard Twin Conductor 30% Rubber Insulated for 5000 Volts Service

Size of Conductor American Wire Gauge (B. & S.)	No. of Wires	Thickness of Insulation Inches	Thickness of Lead Covering Inches	Approx. O. D. Over Jute		Approx. Weight per 1000 ft.
				Max.	Min.	
No. 8	1	$\frac{9}{64}$	$\frac{1}{16}$	1.356	.923	1678
6	1	$\frac{9}{64}$	$\frac{1}{16}$	1.424	.957	1849
4	7	$\frac{9}{64}$	$\frac{5}{64}$	1.595	1.058	2456
2	7	$\frac{9}{64}$	$\frac{5}{64}$	1.715	1.118	2839
1	19	$\frac{9}{64}$	$\frac{5}{64}$	1.793	1.157	2963
1-0	19	$\frac{9}{64}$	$\frac{5}{64}$	1.877	1.199	3239
2-0	19	$\frac{9}{64}$	$\frac{5}{64}$	1.967	1.244	3726
3-0	19	$\frac{9}{64}$	$\frac{5}{64}$	2.071	1.296	4139
4-0	19	$\frac{9}{64}$	$\frac{5}{64}$	2.185	1.353	4629

Each conductor covered with one .012" rubber filled tape. Laid parallel.

Covered with one serving .075" thickness of saturated jute, two coverings of .020" metal tapes and one serving .068" thickness of saturated jute, compound finish.

## Standard Three Conductor 30% Rubber Insulated for 5000 Volts Service

Size of Conductor American Wire Gauge (B. & S.)	No. of Wires	Thickness of Insulation Inches	Thickness of Lead Covering Inches	Approx. O. D. Over Jute	Approx. Weight per 1000 ft.
No. 8	1	$\frac{9}{64}$	$\frac{3}{32}$	1.512	2888
6	1	$\frac{9}{64}$	$\frac{3}{32}$	1.583	3171
4	7	$\frac{9}{64}$	$\frac{3}{32}$	1.734	3750
2	7	$\frac{9}{64}$	$\frac{3}{32}$	1.864	4348
1	19	$\frac{9}{64}$	$\frac{3}{32}$	1.949	4750
1-0	19	$\frac{9}{64}$	$\frac{7}{64}$	2.069	5618
2-0	19	$\frac{9}{64}$	$\frac{7}{64}$	2.166	6178
3-0	19	$\frac{9}{64}$	$\frac{7}{64}$	2.318	6867
4-0	19	$\frac{9}{64}$	$\frac{7}{64}$	2.443	7668

Each conductor covered with one .012" rubber filled tape. Three conductors twisted together with saturated jute fillers and one .012" rubber filled tape over all.

Covered with one serving .075" thickness of saturated jute (and on sizes No. 8 to 2/0 inclusive, two coverings of .020" metal tapes, sizes No. 3/0 and 4/0, two coverings of .030" metal tapes) and one serving .068" thickness saturated jute, compound finish.

# **Standard Specifications for Amparak Intermediate Grade Rubber Insulated Wire and Cable**

The rubber compound shall be made up of the best Hevea rubber and reclaimed rubber, suitable mineral matter, the necessary solid waxy hydrocarbons and sulphur. It is to be carefully and thoroughly vulcanized in the most approved manner and after vulcanization shall be homogeneous, tough and elastic. The insulation shall adhere closely to the wire and be placed concentrically around it.

## **Chemical**

Tests shall be made of the rubber compound for acetone extract, alcoholic potash extract chloroform extract, ash and total sulphur. The summation of the results of these five tests shall not exceed 75% of the total compound, according to Underwriters' Laboratories' method of procedure for chemical tests of rubber compounds used on wires and cables.

## **Mechanical**

A strip of the vulcanized compound not less than four inches long shall be taken from the wire and marks placed on it two inches apart. The sample shall then be stretched until the marks are six inches apart and then immediately released. Thirty seconds after such release the marks shall be not more than  $2\frac{3}{8}$  inches apart. The sample shall then be stretched until the marks are 9 inches apart before breaking. The tensile strength of the compound shall be not less than 800 lbs. per square inch. These tests should be made at ordinary room temperature and in any case at not less than 50 degrees Fahrenheit.

## **Finish**

The wire shall have a suitable finish with our special "Asawco" compound. The compound shall not melt when the finished wire is subjected to a temperature of one hundred and twenty-five degrees (125° F.) Fahrenheit.

### Electrical

Each and every length of conductor shall withstand a voltage test, and shall show an insulation resistance in accordance with the following tables. These tests shall be made at the works of the manufacturer, after the conductor shall have been covered with the rubber compound, and properly vulcanized, and either before or after the application of braid or other protection, at the discretion of the purchaser. They shall be made after twelve hours or more immersion in water, and while the wire is still immersed.

The insulation resistance tests shall be made after the voltage test, with a battery of not less than 150 nor more than 500 volts, and the necessary readings shall be taken after an electrification of one minute.

### Insulation Resistance and Voltage Tests

American Wire Gauge (B. & S.)	Insulating Wall in Accordance with Require- ments of the National Board of Fire Underwriters	Insulation Resistance in Megohms at 60° F. Per Mile	Voltage Test for Five Minutes
14 Solid.....	3-64 inch	1400	2000
12 Solid.....	3-64 inch	1200	2000
10 Solid.....	3-64 inch	1000	2000
8 Solid.....	3-64 inch	860	2000
6 Strand.....	4-64 inch	810	2500
4 Strand.....	4-64 inch	680	2500
2 Strand.....	4-64 inch	550	2500
1 Strand.....	5-64 inch	600	3000
0 Strand.....	5-64 inch	550	3000
00 Strand.....	5-64 inch	490	3000
000 Strand.....	5-64 inch	440	3000
0000 Strand.....	5-64 inch	410	3000
C. M.			
250,000.....	6-64 inch	440	4000
300,000.....	6-64 inch	410	4000
400,000.....	6-64 inch	360	4000
500,000.....	6-64 inch	320	4000
600,000.....	7-64 inch	350	5000
700,000.....	7-64 inch	320	5000
800,000.....	7-64 inch	300	5000
900,000.....	7-64 inch	280	5000
1,000,000.....	7-64 inch	270	5000
1,250,000.....	8-64 inch	280	6000
1,500,000.....	8-64 inch	250	6000
1,750,000.....	8-64 inch	240	6000
2,000,000.....	8-64 inch	220	6000

NOTE: These tests are greatly in excess of the tests called for by the National Board of Fire Underwriters, and are a synonym of high electrical quality.

### Inspection

The purchaser may, at his discretion, send to the works of the manufacturer a representative who shall be afforded every facility to make all the electrical and mechanical tests set forth in these specifications.

# Specifications for ASW 30% Rubber Insulated Wire and Cable

The rubber compound shall be made up of the best Hevea rubber, suitable mineral matter, the necessary solid waxy hydrocarbons and sulphur. It is to be carefully and thoroughly vulcanized and after vulcanization shall be homogeneous, tough, and elastic. The insulation shall adhere closely to the wire and be placed concentrically around it.

**Chemical Analysis:** Analysis of this compound shall show not less than 30% of pure Hevea rubber, not more than 4% of solid waxy hydrocarbons, not more than 0.7% of free sulphur and not more than 2.5% of total sulphur in any form. The analysis shall not show the presence of organic matter other than so-called mineral waxes and the substances normally present in Hevea rubber.

The specific gravity of the rubber compound on the wire shall not be less than 1.75% as compared with the distilled water at 60 degrees F.

**Mechanical Test:** A strip of the vulcanized compound not less than four inches long shall be taken from the wire and marks placed at two inches apart. The sample shall then be stretched until the marks are six inches apart and then immediately released. Thirty seconds after such a release the marks shall not be over  $2\frac{3}{8}$  inches apart. The sample shall then be stretched until the marks are ten inches apart before breaking.

The tensile strength of the compound shall not be less than 1,000 pounds per square inch. The tests shall be made at ordinary room temperature and in any case not less than 50 degrees F.

**Electrical Test:** Each and every length when tested shall withstand a voltage test, and shall show an insulation resistance according to the following tables. These tests shall be made at the works of the manufacturer, after the conductor has been covered with compound and same has been vulcanized, and before application of any other covering except tape where required by manufacturing process.

Tests to be made after at least thirty-six hours' immersion in water and while the wire is still immersed. The insulation resistance tests shall be made after the voltage test with a battery of the proper electromotive force and the necessary readings obtained after one minute's electrification.

## Electrical Tests

Size American Wire Gauge (B. & S.)	Insulating Wall in Accordance with Require- ments of the National Board of Fire Underwriters	Insulation Resistance in Megohms at 60° F. Per Mile	Voltage Test for Five Minutes
14	3-64 inch	2000	2500
12	3-64 inch	1650	2500
10	3-64 inch	1450	2500
8	3-64 inch	1180	2500
6	4-64 inch	1140	3000
4	4-64 inch	940	3000
2	4-64 inch	760	3000
1	5-64 inch	830	3500
1-0	5-64 inch	760	3500
2-0	5-64 inch	680	3500
3-0	5-64 inch	620	3500
4-0	5-64 inch	570	3500
225,000 CM	6-64 inch	620	4250
300,000 CM	6-64 inch	570	4250
400,000 CM	6-64 inch	500	4250
500,000 CM	6-64 inch	450	4250
600,000 CM	7-64 inch	480	5000
700,000 CM	7-64 inch	450	5000
800,000 CM	7-64 inch	420	5000
900,000 CM	7-64 inch	390	5000
1,000,000 CM	7-64 inch	380	5000
1,250,000 CM	8-64 inch	340	5000
1,500,000 CM	8-64 inch	310	6000
1,750,000 CM	8-64 inch	290	6000
2,000,000 CM	8-64 inch	270	6000

**Inspection:** The purchaser may, at his discretion, send to the works of the manufacturer a representative who shall be afforded every opportunity to see that the foregoing specifications are complied with.



## For Station Wiring, Arc Light and Signal Service, High Voltage Power Transmission Lines

THESE rubber-covered wires and cables are made to the most exacting specifications; in any size or finish and for all services and voltages. The insulation contains only the highest grade of Hevea rubber and other necessary preservative ingredients. The exact composition of the rubber compound used and the thickness of the rubber insulation will in every case be determined by the working voltage and by the nature of the service. The conductors will be furnished solid, stranded or extra flexible as ordered, annealed and heavily tinned.



Solid Conductor, Insulated and Braided



Twin Signal Wires, Insulated and Braided

### Amerite Rubber Covered Wires

#### Standard Specifications

The rubber compound shall be made up from Hevea rubber of the best quality, suitable mineral matter, the necessary solid waxy hydrocarbons and sulphur. It is to be carefully and thoroughly vulcanized in the most approved manner and after vulcanization shall be homogeneous, tough and elastic. The insulation shall adhere closely to the wire and be placed concentrically around it.

#### Chemical

Analysis of this compound shall show not less than 30% of best grade Hevea rubber, not more than 4% of solid waxy hydrocarbons, not more than 0.7% of free sulphur, and not more than 2.25% of total sulphur in any form. The analysis shall not show the presence of organic matter other than so-called mineral waxes and the substances normally present in Hevea Rubber.

The specific gravity of the compared rubber compound on the wire shall be not less than 1.85 as with distilled water at 60 degrees F.

The tape over all increases the diameter .024 inch (.012 inch on a side).

Price of finish is found in the regular way based upon this diameter.

**Mechanical**

A strip of the vulcanized compound not less than four inches long shall be taken from the wire and marks placed on it two inches apart. The sample shall then be stretched until the marks are six inches apart and then immediately released. Five seconds after such a release the marks shall not be over  $2\frac{3}{8}$  inches apart. The sample shall then be stretched until the marks are 10 inches apart before breaking.

The tensile strength of the compound shall be not less than 1250 lbs. per square inch.

These tests shall be made at ordinary room temperatures and in any case not less than 60 degrees F.

**Electrical**

Each and every length of conductor when tested shall withstand a voltage test, and shall show an insulation resistance according to the following tables. These tests shall be made at the works of the manufacturer, after the conductor has been covered with compound and same has been vulcanized, and before the application of tape, or other covering.

Tests shall be made after at least thirty-six hours' immersion in water and while the wire is still immersed. The insulation resistance tests shall be made after the voltage test with a battery of the proper electromotive force and the necessary readings obtained after one minute's electrification.

**Inspection**

The purchaser may, at his discretion, send to the works of the manufacturer a representative who shall be afforded every opportunity to see that the foregoing specifications are complied with.

**Amerite Rubber Covered Wires****Voltage Tests for a Five Minute Period**

	THICKNESS OF INSULATION, INCHES									
	3-64	2-32	5-64	3-32	7-64	4-32	5-32	6-32	7-32	8-32
All Sizes.....	3000	4500	6000	7500	9000	10500	13000	16000	18000	20000

**Amerite Rubber Covered Wires****30 Per Cent Hevea Rubber Compound****Megohms per Mile after a One Minute Electrification at 60 Degrees F.**

Size—Circular Mils	THICKNESS OF INSULATION, INCHES									
	3-64	2-32	5-64	3-32	7-64	4-32	5-32	6-32	7-32	8-32
<b>STRANDED</b>										
1,000,000.....					515	650	800	925	1050	1200
900,000.....					600	675	825	975	1100	1250
800,000.....					650	715	875	1025	1150	1300
700,000.....					675	750	950	1075	1250	1375
600,000.....					750	850	1000	1150	1300	1450
500,000.....				675	800	900	1050	1250	1400	1600
400,000.....				750	875	950	1150	1375	1550	1750
300,000.....				875	1000	1100	1350	1550	1750	1950
250,000.....				950	1050	1200	1450	1650	1850	2050

Amerite Rubber Covered Wires

30 Per Cent Hevea Rubber Compound

Megohms per Mile after a One Minute Electrification at 60 Degrees F.

Size—Circular Mills	THICKNESS OF INSULATION, INCHES									
	3-64	2-32	5-64	3-32	7-64	4-32	5-32	6-32	7-32	8-32
Stranded										
American Wire Gauge (B. & S.)										
4-0.....			860	1000	1120	1250	1550	1750	1950	2200
3-0.....			950	1100	1250	1400	1650	1950	2150	2400
2-0.....			1050	1200	1400	1550	1850	2100	2350	2600
1-0.....			1150	1350	1520	1700	2050	2350	2550	2800
1.....			1250	1500	1650	1850	2200	2500	2750	3020
2.....		1150	1400	1650	1850	2050	2400	2700	3000	3250
3.....		1300	1500	1775	2000	2200	2550	2900	3250	3500
4.....		1450	1700	1950	2200	2400	2800	3200	3500	3800
5.....		1500	1825	2100	2400	2600	3000	3400	3700	4000
6.....		1700	1950	2320	2600	2850	3300	3650	4000	4350
Solid										
American Wire Gauge (B. & S.)										
8.....	1800	2250	2600	2950	3300	3550	4050	4500	4900	5250
9.....	1950	2450	2800	3150	3550	3800	4350	4800	5200	5500
10.....	2150	2650	3060	3450	3800	4100	4650	5100	5500	5850
12.....	2550	3100	3550	3950	4300	4650	5200	5700	6150	6500
14.....	3000	3600	4080	4500	4900	5260	5850	6350	6800	7200

LEAD-COVERED CABLE



Stranded Four-Conductor Rubber Insulated, Taped, Juted and Lead Sheathed Cable

## Lead-Covered Cables

### Rubber Insulated

We make a specialty of heavy rubber cables, lead sheathed, armored, or lead-encased and armored, for all services and voltages, and finished in any style. These are made to meet the most exacting requirements, such as those specified for government and for railway signal service, underground, submarine, or aerial. While taped and braided rubber wires and cables are used for inside and submarine service with entire satisfaction without any lead sheathing, experience has demonstrated the advisability of enclosing the cable in a sheath whenever it is to be used in conduits for underground work, or where it would be exposed to acids, gases, extreme temperature changes, or other destructive agencies.

The composition and properties of our rubber insulations have already been described. Great care is taken in the preparation of our rubber compounds, and in selection of the rubber and the necessary mineral ingredients. The rubber compound is applied to the conductor in layers under great pressure, thus insuring the centralization of the conductor, and also preventing the formation of air holes in the body of the dielectric. Any number of conductors thus insulated can be stranded into a core or cable, the interstices between the conductors usually being rounded out with jute fillers. In this condition, the cable is ready for the application of the tape and lead sheath, or as sometimes required, a supplementary belt of rubber insulation, and then the tape and sheath or other protection.

All copper conductors are annealed thoroughly and tinned, and have a guaranteed conductivity in accordance with the standardization rules of the American Institute of Electrical Engineers and the American Society for Testing Materials.

Rubber insulated cables may be finished in any one of the following ways, as may be specified:

Taped, or braided and leaded.

Taped, leaded and braided, weatherproof, soapstone or flameproof finish.

Taped, leaded and juted.

Taped, leaded, juted and armored.

Taped, leaded, juted, armored and juted.

Taped, juted and armored.

Taped, juted, armored and juted.

A tracer thread is always laid underneath the tape.

Cables may be taped and braided instead of taped, and in each case one, two or three reverse layers of jute can be used. Other combinations are sometimes required which can be made as specified.

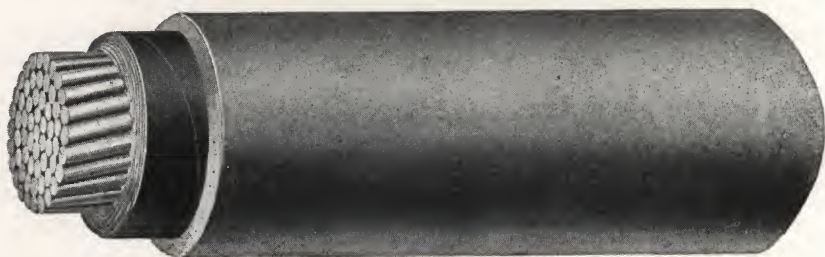


Stranded Tinned Copper Conductor, Rubber Insulated, Taped and Lead Sheathed Cable

AMERITE and ASW 30% Cables:—For high tension service 7,000 volts and over. Used by contractors and lighting plants where high grade material is desired or where the service is very severe.

AMERICORE Cable. (National Code Standard):—These cables have an insulation which has made a lasting record for long life and for high insulating qualities. The thickness of rubber required by the National Board of Fire Underwriters provides a wide margin of safety and gives a high grade insulation for all lower voltages.

### **Paper Insulated Lead Sheathed Cables**



For many years past we have manufactured large quantities of paper cables, single and multiple conductor. Our factory equipment is unexcelled for making this class of material to the most exacting specifications.

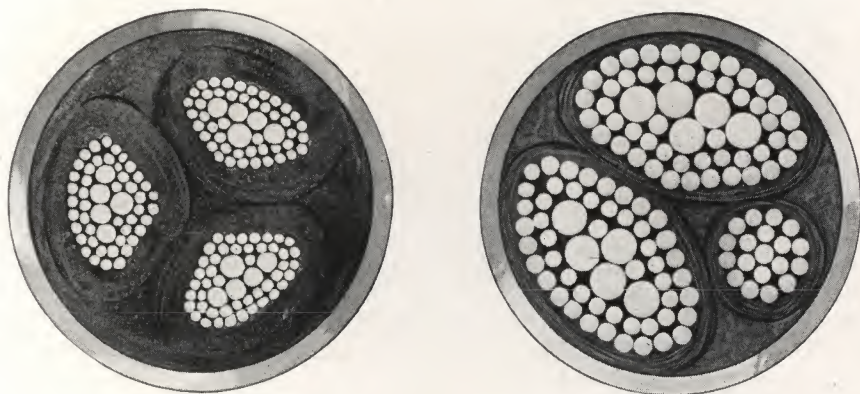
In the construction of paper cables, for electric light and power purposes, narrow and very thin strips of pure Manila paper are wound spirally about the conductor in sufficient number of layers for the required dielectric strength. The material which we use is the very best grade of Manila rope paper, uniform in texture, containing no particles of mineral substances, wood pulp or low grade materials, no pin holes and no trace of alkalis or residual chemicals. The selection of a high grade paper is most essential for permanence and for good dielectric properties.

After the paper covering has been applied to the single conductor, or to the core of conductors in the form of a belt, every trace of air and moisture is removed from the cable by special processes, and while in this condition the core is thoroughly saturated and all interstices completely filled with insulating compound of high dielectric strength. The cable is then put through a hydraulic press and covered with a closely fitting lead sheathing so as to exclude all air and moisture and to retain the insulating compound. A tracer thread is placed lengthwise of all cables underneath the sheath.

The dielectric value of paper insulation not only depends upon the quality of the paper and the manner of applying it to the conductor, but to a great extent upon the composition of the insulating compound. A compound is used which has excellent insulating qualities at or above operating temperatures as well as giving low dielectric loss. This compound has no chemical action on the paper or conductor and retains a plastic state at low temperatures.

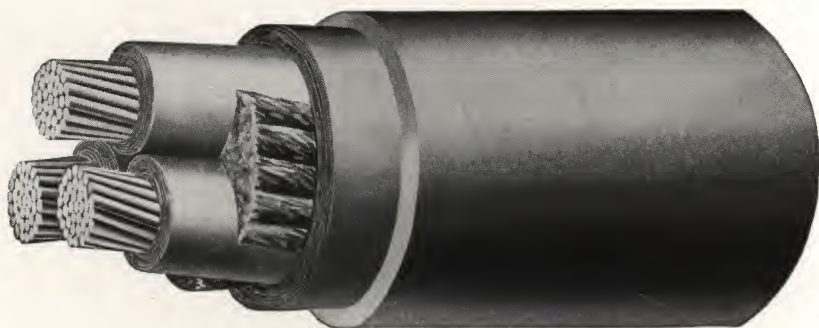
Paper cables are generally cheaper and have a lower electro-static capacity than rubber or varnished cambric cables. The insulation is strong and uniform in quality, and except when frozen solid, is quite flexible. Paper cables can be worked safely at a high temperature, and experience has demonstrated that their useful life is practically determined by the integrity of the sheathing. Paper is less liable than rubber to deterioration from excessive electro-static strains. In short, the paper insulated cable when properly constructed and sheathed can be recommended as one of the best for most conditions.

### Sector Shaped Conductor Cables



Three conductor, paper insulated cables can be furnished with sector shaped conductors, effecting a reduction in overall diameter and weight. With a given duct, size and working voltage the sector type of construction will allow the installation of maximum copper section. This type of cable is made only with paper insulation and is recommended for sizes from No. 2-0 A.W.G. to 500,000 C.M.

## Varnished Cambric Cables



A single-conductor varnished cambric cable is made by winding tapes of thin varnished cloth spirally about the conductor in a sufficient number of smooth, tightly drawn layers to make the required thickness of dielectric. The varnished cloth used has been multiple coated with special insulating varnish and has sufficient dielectric strength to withstand a stress of 7,000 to 12,000 volts for a single thickness. A plastic non-hardening insulating compound is applied between the layers of cambric which prevents the tape from unwrapping when the cable is cut, and permits the adjoining layers of varnished cambric to slide upon each other, thus insuring a concentric condition when the cable is bent. This compound prevents capillary absorption of moisture between the layers of tape, seals any possible skips in films and precludes air spaces.

In multiple-conductor cables, it is usual to place a portion of the required thickness of insulation in the form of a belt about the core of conductors, as in the case with paper cables.

This class of cables is in general more flexible than paper cables, more impervious to moisture, reasonable in cost, and can be used in dry places such as for station wiring without lead sheathing. When no sheathing is required the cable is protected by a cotton braid, or with an asbestos braid for fire protection. These braids are saturated in weatherproof compounds or in slow-burning compounds, as may be required. Oil and grease have practically no injurious effect on varnished cambric and may be used under such conditions where other insulation would not be advisable.

We make these cables in any quantity, of any size or type and for any voltage or service condition, to the most rigid specifications.

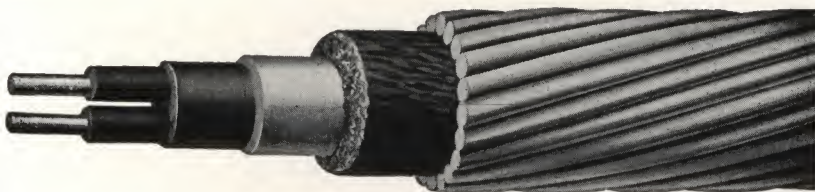
Inquiries containing full information as to working conditions are solicited and prices will be quoted on application.

## Submarine Cables

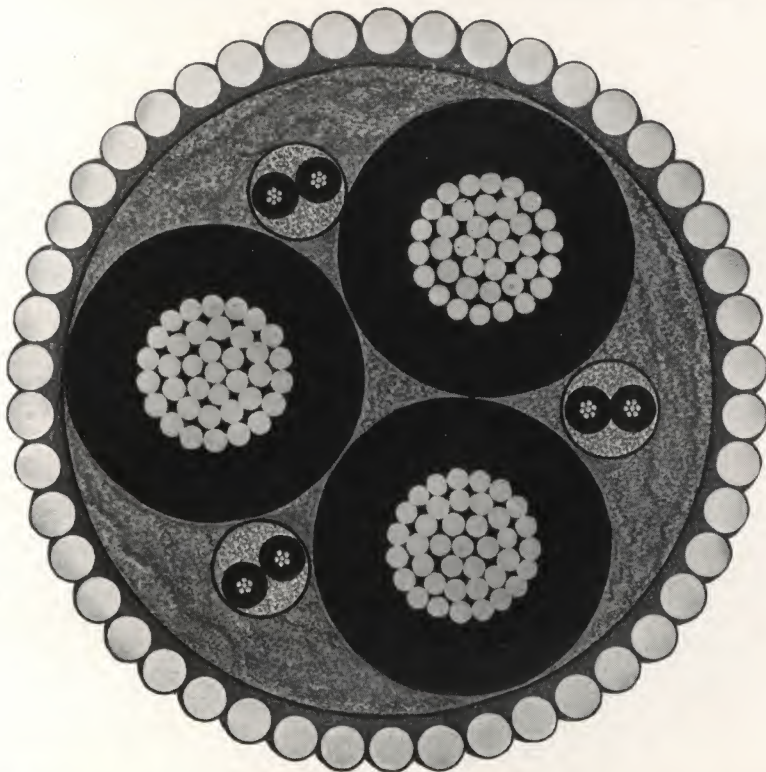
We manufacture and install large quantities of submarine cables of every design for street railways, telegraph and telephone companies and electric light and power plants. These are used for crossing rivers, bays, ponds, or lakes. Our factory is well prepared for furnishing this class of material to the most exacting specifications.

Full information as to the purpose for which the cable is to be used, location, depth of water and working conditions should accompany requests for prices.

Inquiries solicited.



Two-conductor Submarine Cable, Lead Encased, Jute Served and Armored



Showing Section of 8-mile Length of 500,000 C. M. Stranded Three-conductor Rubber Insulated Steel Wire Armored Submarine Power Cable for 11,000 Volts W. P. with Three Sets of Telephone Conductors as Manufactured for Great Western Power Co. of California Laid Across San Francisco Bay during 1923  
Actual Size

## Rail Bonds

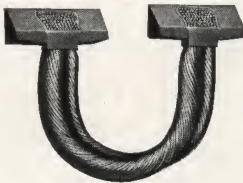
We are exceptionally well equipped to make Rail Bonds of any desired type, capacity, or length to meet any requirements. A separate Rail Bond Catalogue, showing many other types, is issued, furnished upon request.

We illustrate several standard styles of Rail Bonds as follows:



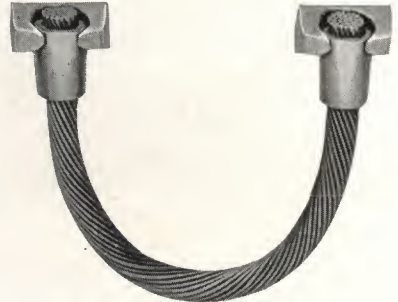
**Type C. P. 02 (Balanced)**

Crown Rail Bonds with solid or flexible conductors. Can be furnished for installation beneath or around the fish plate or splice bar.



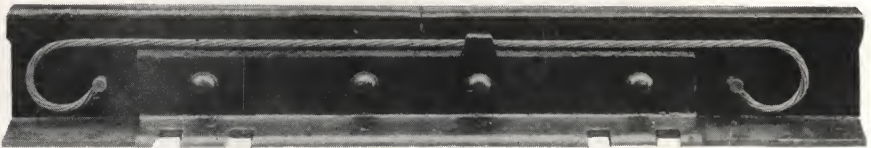
**Type F. S. A.-2**

Flame Weld Bonds for application to the ball of the rail by use of the oxy-acetylene torch and special copper flux wire. These rail bonds can be furnished with copper or steel terminals.



**Type F-1**

Flame Weld Signal Bonds. These rail bonds are particularly adapted for steam railway signal service.



**Types SS, S-1, S-2, and S-3**

These bonds are composed of stranded conductors of Extra Galvanized E.B.B. wires with  $\frac{3}{8}$  in. diameter tapered steel terminals electrically welded thereto. One form carries an annealed copper wire in the center. The length may be varied at the discretion of the customer, depending upon the manner in which the bond is to be applied. The standard length is 46 in.



**Type AC**

Arc Weld Rail Bond Steel Welding Face, designed for application to either ball of rail or base around angle bars by metallic electrode process.

Only pure annealed copper of high conductivity is used in any portion of these bonds. The solid and tubular terminals after being forged to shape from rolled copper rods, are heated and drop forged to the solid or flexible conductor portion, producing a union having all the merits of homogeneous copper.

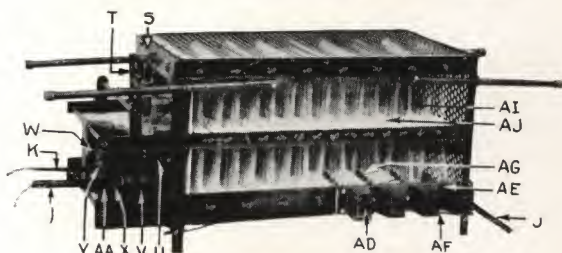
Two styles of stud terminals may be used on the Crown or on the United States bonds. One is a tubular terminal, applied to the rail by driving a long taper punch through the hollow terminal, distending it radially after which a short drift pin is driven into the terminal, expanding it  $\frac{1}{32}$ -inch more. The other style of terminal has a solid stud and is installed with a compressor.

The durability and efficiency of a bond installation will depend largely upon the effectiveness of the tools used. In developing our bonding tools no expense has been spared nor time considered. First and foremost, the aim has been to produce tools of the greatest effectiveness and perfect suitability for the service to which they were to be put; to make them as perfect in every detail as possible, and to make them light, durable and reasonable in cost.

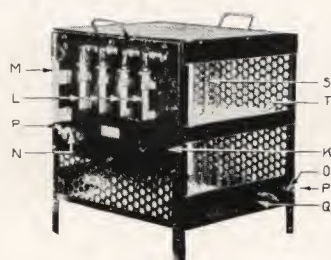
A new and revised rail bond catalogue describing our complete bonding equipment will be sent on request.

Correspondence is solicited and data and estimates will gladly be furnished.

## Rail Bonding and Arc Welding Machines



Railway Type



Mine Type

These machines are essentially arc welding outfits, suitable for all kinds of metallic arc welding as well as for the application of rail bonds. They are also suitable for light carbon welding and cutting. The rheostat has a range from 60 to 200 amperes in steps of 15 amperes. The control of the current enables the operator to obtain the exact amount of power suited to the work he is doing, which is quite essential for the best results. Railway type machine operates on 400 to 650 volt circuits. Mine type, 200 to 275 volts.

## American W. & M. Telephone and Telegraph Wire, Extra Galvanized



There are three standards of extra galvanized telephone and telegraph wire in general commercial use as follows:

"EXTRA BEST BEST" (E. B. B.). Made by improved continuous process and stands highest in conductivity of any telegraph wire with a weight per mile ohm of from 4700 to 5000 pounds. Uniform in quality, pure, tough and pliable. It is largely used by telegraph companies and in railway telegraph service.

"BEST BEST" (B. B.). Superior to the E. B. B. in mechanical qualities and equal in galvanizing, but of somewhat lower electrical value. Weight per mile ohm, 5600 to 6000 pounds. This grade is used very largely by telephone companies.

"STEEL" (or homogeneous metal). More expressly designed for short-line telephone service, where a measure of conductivity can be exchanged for high tensile strength in a light wire. Weight per mile ohm, 6500 to 7000 pounds.

While these three grades differ in physical characteristics, there is no difference in the standard as regards galvanizing. All grades are galvanized to the highest commercial standard — a standard which is the result of more than half a century's experience.

Around each bundle is securely riveted a metal seal stamped W. & M. E. B. B., W. & M. B. B. or W. & M. Steel.

### Resistance and Weights of Telegraph and Telephone Wires

Averages of a large number of tests.

Birmingham Wire Gauge	Diameter in Inches	Weight in Pounds Per 1,000 Feet	Weight in Pounds per Mile	In Bundles (Miles)	Approximate Breaking Strain (Pounds)			Average Resistance per Mile at 68° F. (International Ohms)		
					E. B. B.	B. B.	Steel	E. B. B.	B. B.	Steel
4	.238	153	811	1/4	2,028	2,271	2,433	5.98	7.15	8.32
6	.203	112	590	1/3	1,475	1,652	1,770	8.22	9.83	11.44
8	.165	74	390	1/2	975	1,092	1,170	12.43	14.87	17.31
9	.148	60	314	1/2	785	879	942	15.44	18.47	21.50
10	.134	49	258	1/2	645	722	774	18.79	22.48	26.16
11	.120	39	206	1/2	515	577	618	23.54	28.16	32.77
12	.109	32	170	1/2	425	476	510	28.52	34.12	39.71
14	.083	19	99	1/2	247	277	297	48.98	58.59	68.18

The values in the above table represent our standard product. We will supply wire to special specifications when required.

The resistance per mile in any case is obtained by dividing the weight per mile ohm by the weight per mile.

### Extra Galvanized Bond Wire

Used for signal bonding on steam roads. Extra B. B. extra galvanized telephone wire is nearly always used for this purpose. Cut and straightened to lengths at a small extra charge. Usually 3 to 5 feet long, and of any gauge number desired.

Tie wires usually furnished in 13-inch lengths are used for fastening telegraph and telephone wires to the insulators.

## Pole Steps



Sizes	Approximate Weight per 100 Pole Steps		Sizes	Approximate Weight per 100 Pole Steps	
	Plain	Galvanized		Plain	Galvanized
8 x $\frac{5}{8}$ inch	73 pounds	75 pounds	8½ x $\frac{9}{16}$ inch	58 pounds	61 pounds
9 x $\frac{5}{8}$ inch	78 pounds	81 pounds	9 x $\frac{9}{16}$ inch	62 pounds	65 pounds
10 x $\frac{5}{8}$ inch	85 pounds	88 pounds	10½ x $\frac{9}{16}$ inch	71 pounds	74 pounds
10½ x $\frac{5}{8}$ inch	89 pounds	93 pounds	9 x ½ inch	51 pounds	54 pounds

For the use of electric light, street railway and telephone companies.

The above are with our regular spike and button heads.

Lengths given are measurements over all.

Each step carefully threaded with screw thread.

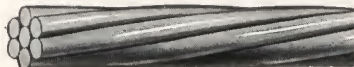
Special shapes or lengths of heads made to order.

A keg of pole steps weighs about 200 pounds.

Can be furnished plain or galvanized.

## Strand

### Steel Strand for Guying Poles and for Span Wire



#### Seven Steel Wires Twisted into a Single Strand, Galvanized or Extra Galvanized

Diameter Inches	Size of Wire Used, American Steel & Wire Company Steel Wire Gauge	Approximate Weight per 1,000 Feet in Pounds	Approximate Strength in Pounds	Diameter Inches	Size of Wire Used, American Steel & Wire Company's Steel Wire Gauge	Approximate Weight per 1,000 Feet in Pounds	Approximate Strength in Pounds
$\frac{3}{4}$	3	1,200	16,700	$\frac{1}{4}$	14	121	1,900
$\frac{5}{8}$	5	813	11,600	$\frac{7}{32}$	15	98.3	1,540
$\frac{9}{16}$	6	671	9,600	$\frac{3}{8}$	16	72.9	1,150
$\frac{7}{2}$	8	517	7,400	$\frac{3}{32}$	17	51.3	870
$\frac{7}{16}$	9	399	5,700	$\frac{1}{8}$	19	31.8	540
$\frac{3}{8}$	11	296	4,250	$\frac{3}{32}$	21	20	400
$\frac{5}{16}$	12	205	3,200	..	..	..	....

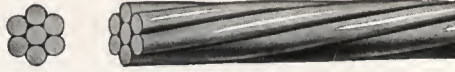
#### Nineteen Wires Twisted into a Single Strand, Galvanized or Extra Galvanized

Diameter Inches	Diameter of Wire	Approximate Weight per 1,000 Feet in Pounds	Approximate Strength in Pounds	Diameter Inches	Diameter of Wire	Approximate Weight per 1,000 Feet in Pounds	Approximate Strength in Pounds
1	.200	2,073	28,700	$\frac{5}{8}$	.125	796	11,000
$\frac{7}{8}$	.175	1,581	21,900	$\frac{9}{16}$	.110	637	9,640
$\frac{3}{4}$	.150	1,155	16,000	$\frac{1}{2}$	.100	504	7,620

This strand is used chiefly for guying poles and smoke stacks, for supporting trolley wire and for operating railroad signals.

For overhead catenary construction suspending trolley wire the special grades of strand are considered preferable because they possess greater strength and toughness.

# Extra Galvanized Special Strand



## Seven and Nineteen Steel Wires Twisted into a Single Strand

We manufacture three qualities of special grades of Extra Galvanized Strand that should meet all requirements for durability, strength, toughness and light weight.

Extra Galvanized Siemens-Martin Strand.

Extra Galvanized High Strength (Crucible Steel) Strand.

Extra Galvanized Extra High Strength (Plow Steel) Strand.

All three qualities are composed of seven or nineteen wires having the heaviest coating of galvanizing that will ensure the longest life.

GRADE	7 WIRES	Diameter in Inches	19 WIRES
	Tensile Strength in Pounds		Tensile Strength in Pounds
Siemens-Martin.....	19,100	$\frac{5}{8}$	18,100
	12,100	$\frac{1}{2}$	12,700
	9,350	$\frac{7}{16}$	9,000
	6,950	$\frac{3}{8}$	6,800
	5,350	$\frac{5}{16}$	.....
	4,250	$\frac{3}{4}$	.....
	3,150	$\frac{1}{4}$	.....
	1,900	$\frac{3}{16}$	.....
	910	$\frac{1}{8}$	.....
High Strength.....	29,600	$\frac{5}{8}$	28,100
	18,800	$\frac{1}{2}$	19,100
	14,500	$\frac{7}{16}$	15,000
	10,800	$\frac{3}{8}$	11,500
	8,000	$\frac{5}{16}$	.....
	6,400	$\frac{3}{4}$	.....
	4,750	$\frac{1}{4}$	.....
	2,850	$\frac{3}{16}$	.....
	1,330	$\frac{1}{8}$	.....
Extra High Strength.....	42,400	$\frac{5}{8}$	40,200
	26,900	$\frac{1}{2}$	26,700
	20,800	$\frac{7}{16}$	22,500
	15,400	$\frac{3}{8}$	17,250
	11,200	$\frac{5}{16}$	.....
	8,950	$\frac{3}{4}$	.....
	6,650	$\frac{1}{4}$	.....
	3,990	$\frac{3}{16}$	.....
	1,830	$\frac{1}{8}$	.....

Prices upon application.

# Armature Binding Wire

## American Tinned Steel

American Wire Gauge (B. & S.)	Diameter in Inches	Actual Tensile Strength in Pounds			
		Grade A	Grade B	Grade C1 or Special	Grade C2 or C
10	.1019	938	1,631	1,957	2,447
11	.0907	743	1,292	1,551	1,938
12	.0808	590	1,026	1,231	1,538
13	.072	468	814	977	1,221
14	.0641	371	645	774	968
15	.0571	294	512	615	768
16	.0508	233	405	486	608
17	.0453	185	322	387	484
18	.0403	147	255	306	383
19	.0359	116	202	243	304
20	.032	92.5	181	193	241
21	.0285	73.4	128	133	191
22	.0253	57.8	101	121	151
23	.0226	46.1	80.2	88.3	120
24	.0201	30.5	63.5	76.2	95.2
25	.0179	28.9	50.5	60.4	75.5
26	.0159	22.8	39.7	47.7	59.6

**Grade A.** 115,000 to 125,000 lbs., tensile strength per square inch. Used to bind Armatures of small motors and dynamos.

**Grade B.** 200,000 to 220,000 lbs., tensile strength per square inch. Commercial grade. For motors and dynamos of ordinary commercial size and speed.

**Grade C1 or Grade Special.** 240,000 to 270,000 lbs., tensile strength per square inch. Made of high grade rope wire and used where great strength is required.

**Grade C2 or Grade C.** 300,000 to 350,000 lbs., tensile strength per square inch. Used when very high tensile strength is required, as on motors and dynamos of unusual size and high speed.

Armature Binding Wire is furnished in coils or on spools.

Standard Coils weighing from 5 to 75 pounds each. Inside diameter of coils, sizes 20 and coarser, 16 inches; finer than 20, 8 inches.

Standard Spools weighing 5, 10, 25, 50 and 100 pounds each.

Prices upon application.

# Reels and Spools

## Standard Shipping Reels and Spools for Electrical Wires and Cables

List Number Burned in Head of Reel or Spool	Old Number	Sym- bol	DIMENSIONS ARE GIVEN IN INCHES					Average Weight in Pounds	*Price per Reel
			Diameter Head	Diameter Barrel	Width Inside	Width Outside	Arbor Hole		
Spool 404	304X	A	3.25	1.0	3.75	5.125	.375°	.3125	No charge
Spool 405	305XV	A	2.75	1.0	3.00	4.375	.375°	.25	No charge
Spool 406	306X	A	6.00	1.375	3.1875	4.0625	.625°	.5	No charge
Reel 415	315XV	W	38.00	16.0	22.50	27.75	1.625°	174.	\$ 14.00
Reel 421	321XV	M	28.00	22.0	6.00	9.50	1.375°	37.	4.50
Reel 422	322XV	W	30.00	12.0	11.00	14.50	1.125°	53.	4.50
Reel 424	0324XV	W	60.00	28.0	32.00	38.50	2.625°	550.	29.00
Reel 428	1028XV	R	72.00	42.0	42.00	50.50	3.625°□	1491.	65.00
Reel 432	1032XV	R	92.00	48.0	55.00	65.50	3.625	2200.	350.00
Reel 433	333XV	W	50.00	28.0	32.00	37.50	2.625°	441.	23.00
Reel 437	1037XV	R	108.00	60.0	64.00	76.00	6.25	4100.	300.00
Reel 440	1040XV	R	80.00	46.0	50.00	58.25	3.625	1850.	110.00
Spool 443	343X	M	7.00	2.375	2.75	3.75	.625°	1.0625	.50
Reel 444	344XV	M	22.00	15.00	5.75	9.75	1.375°	23.	3.00
Spool 447	347X	M	4.50	1.75	2.75	3.75	.625°	.375	.25
Spool 449	349XV	M	9.00	4.50	4.00	6.00	1.00°	3.	1.00
Reel 450	350XV	M	12.00	6.00	5.00	7.50	1.25°	6.50	1.25
Spool 451	0351X	M	6.00	2.375	2.75	3.75	.625°	.75	.25
Reel 454	354X	M	16.00	8.00	5.50	8.50	1.25°	17.	3.00
Reel 460	360V	M	13.25	5.5	4.75	6.25	1.25°	5.	1.25
Reel 465	365	W	30.00	14.00	8.00	11.50	1.625°	47.	5.25
Reel 466	366	W	36.00	20.00	15.00	20.25	1.625°	114.	9.25
Reel 467	367	.....	48.00	32.00	24.00	29.25	2.625°	310.	26.00
Reel 468	368	.....	54.00	36.00	35.00	40.25	2.625°	402.	28.00
Reel 469	369	.....	60.00	38.00	35.00	40.75	2.625°	485.	35.00
Reel 470	370	.....	64.00	40.00	40.00	46.25	2.625°	625.	45.00
Spool 471	.....	M	2.75	1.375	3.875	5.00	.4375	.3	.10
Reel 472	.....	R	60.00	36.00	18.75	24.00	7.5°□	405.	18.00

A — reels for annunciator wire.

R — reels for rubber, paper or cambric insulated wires and cables.

M — reels for magnet wire.

W — reels for weatherproof wires and cables.

\*Price subject to change without notice.

### Reels and Spools

Will be charged at fixed prices. On the Pacific Coast when returned in good condition freight prepaid to the terminal point from or through which shipment is made within six (6) months from date of such shipment they shall be credited at price charged. In all other sections of the United States they shall be credited at the price charged when returned within six (6) months from date of shipment to the factory of the manufacturer in good condition, freight prepaid. All quotations must be made on the basis of reels being returned within six (6) months from date of shipment. If reels are returned after six months from date of shipment no credit will be allowed.

## Standard Shipping Reels and Spools

For Bare Copper Trolley, A. & C. and Tinned Copper, Flat Wire, Tinned Bottling Wire, Covered Wire, Armature Binding Wire and Rope Wire

List Number Burned in Head of Reel or Spool	Old Number	Sym- bol	DIMENSIONS ARE GIVEN IN INCHES					Average Weight in Pounds	*Price per Reel
			Diameter Head	Diameter Barrel	Width Outside	Width Inside	Arbor Hole		
Spool 501	.....	.....	10	3 $\frac{3}{4}$	7	5 $\frac{1}{2}$	3 $\frac{3}{4}$	3.9	\$ 1.25
Reel 502	02XV	T	50	36	19 $\frac{1}{2}$	15	S7 $\frac{3}{8}$	190.	11.50
Reel 504	4XV	A	22	14	11 $\frac{1}{2}$	8	1 $\frac{3}{4}$	28.	3.75
Reel 508	.....	T	36	28	18 $\frac{1}{2}$	15	7 $\frac{3}{8}$	106.	7.50
Reel 509	.....	T	50	36	21 $\frac{1}{2}$	17	7 $\frac{3}{8}$	210.	13.00
Reel 510	.....	T	36	24	25 $\frac{1}{2}$	21	7 $\frac{3}{8}$	135.	7.50
Spool 513	0113XV	R	8 $\frac{1}{2}$	4	6	4 $\frac{1}{8}$	1	3.	1.25
Reel 516	.....	C	6	3	7	5	1 $\frac{1}{2}$	1.2	.15
Spool 517	017XV	C	4	1 $\frac{1}{4}$	6	5	1 $\frac{1}{2}$	.4	.25
Spool 518	018XV	C	3 $\frac{1}{2}$	1 $\frac{1}{4}$	6	5	1 $\frac{1}{2}$	.3	.25
Reel 519	.....	T	45 $\frac{1}{2}$	30	23	17 $\frac{1}{2}$	7 $\frac{3}{8}$ □	204.	13.00
Spool 520	020XV	A	5 $\frac{1}{2}$	2 $\frac{3}{4}$	3	1 $\frac{3}{4}$	5 $\frac{3}{8}$	.7	.25
Spool 523	123V	A	5	3	6 $\frac{1}{2}$	5	5 $\frac{3}{8}$	.9	.50
Spool 527	127V	A	6	1 $\frac{1}{2}$	3 $\frac{3}{4}$	2 $\frac{1}{2}$	5 $\frac{3}{8}$	6.5	.50
Reel 528	128XV	T	44	36	18 $\frac{1}{2}$	15	7 $\frac{3}{8}$	146.	9.50
Spool 529	129X	.....	2 $\frac{3}{4}$	3 $\frac{1}{4}$	3 $\frac{7}{8}$	2 $\frac{7}{16}$	3 $\frac{3}{8}$	.2	.10
Spool 530	130	.....	3 $\frac{1}{2}$	1 $\frac{1}{2}$	3 $\frac{3}{4}$	2 $\frac{3}{4}$	5 $\frac{3}{8}$	.2	.20
Reel 531	131	F	22	16	3 $\frac{3}{4}$	1 $\frac{3}{4}$	1 $\frac{3}{4}$	27.	2.00
Reel 532	132	.....	26	15	9 $\frac{3}{4}$	5 $\frac{3}{4}$	1 $\frac{3}{8}$	30.	3.75
Reel 533	133	A	36	24	19 $\frac{1}{2}$	15	7 $\frac{3}{8}$	102.	8.50
Reel 534	134	.....	5 $\frac{1}{2}$	2 $\frac{3}{4}$	3 $\frac{7}{8}$	2 $\frac{7}{8}$	1 $\frac{1}{16}$	1.25	.50
Reel 535	135	T	46	36	19 $\frac{1}{2}$	16	7 $\frac{3}{8}$	170.	14.00
Spool 539	039X	A	1 $\frac{3}{4}$	1 $\frac{3}{8}$	4	2 $\frac{1}{2}$	3 $\frac{3}{8}$	.075	.10
Spool 540	040XV	A	1 $\frac{3}{4}$	1 $\frac{3}{8}$	2 $\frac{1}{4}$	1 $\frac{1}{4}$	3 $\frac{3}{8}$	.075	.10
Spool 544	044XV	A	1 $\frac{3}{4}$	3 $\frac{1}{4}$	4	2 $\frac{1}{2}$	3 $\frac{3}{8}$	.075	.10
Spool 554	054XV	A	2 $\frac{1}{4}$	1 $\frac{1}{8}$	3 $\frac{7}{16}$	2 $\frac{1}{2}$	1 $\frac{1}{2}$	.075	.10
Spool 558	058X	.....	10	7	2 $\frac{3}{4}$	1 $\frac{1}{2}$	1 $\frac{1}{2}$	2.35	1.25
Spool 566	066XV	.....	2 $\frac{1}{2}$	1 $\frac{1}{8}$	3 $\frac{1}{2}$	2 $\frac{1}{2}$	1 $\frac{1}{2}$	.15	.10
Spool 568	68XV	A	3 $\frac{1}{2}$	1 $\frac{1}{2}$	3 $\frac{3}{4}$	2 $\frac{3}{4}$	5 $\frac{3}{8}$	.225	.25
Spool 572	202	C	6	2 $\frac{1}{4}$	6	5	5 $\frac{3}{8}$	.85	.25
Spool 573	203XV	D	5 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{7}{8}$	1 $\frac{7}{8}$	5 $\frac{3}{8}$	1.	.25
Spool 574	204XV	D	4	1 $\frac{3}{8}$	6 $\frac{1}{2}$	5	9 $\frac{1}{16}$	.45	.25
Spool 575	205XV	D	7	3	6	5	5 $\frac{3}{8}$	1.25	.50
Reel 576	206XV	D	12	4 $\frac{1}{2}$	8 $\frac{1}{4}$	6 $\frac{1}{2}$	1 $\frac{3}{8}$	4.9	1.25
Reel 577	207XV	D	12	3	13	11	5 $\frac{3}{8}$	5.	1.75
Spool 589	089XV	A	5 $\frac{3}{4}$	1 $\frac{1}{2}$	3 $\frac{1}{2}$	2 $\frac{1}{2}$	5 $\frac{3}{8}$	.55	.25
Spool 592	092V	A	9 $\frac{1}{2}$	3	7	5 $\frac{1}{2}$	3 $\frac{1}{4}$	2.45	.75
Spool 593	093V	A	4	2 $\frac{1}{4}$	4	3	5 $\frac{3}{8}$	.4	.25

T—Trolley wire.

A—Annealed and cleaned and tinned copper wire or steel wire.

F—Flat wire.

B—Tinned bottling wire.

C—Covering wire.

R—Rope wire.

D—Armature binding wire.

\*Price subject to change without notice.

## Steel Strand Reels—All Works

New Number	Old Number	Diameter of Head in Inches	Diameter of Barrel in Inches	Width Inside in Inches	Width Outside in Inches	Arbor Hole in Inches	Average Weight in Pounds	*Price per Reel
900	700XV	42	20	24	27 $\frac{1}{2}$	2 $\frac{3}{4}$	140	\$9.00
901	701XV	38	20	24	27 $\frac{1}{2}$	2 $\frac{3}{4}$	125	7.25
902	702X	36	20	24	27 $\frac{1}{2}$	2 $\frac{1}{2}$	105	7.25
903	703X	35	16	14 $\frac{1}{2}$	18	2 $\frac{1}{2}$	80	6.25
904	704XV	35	16	14	18	2 $\frac{3}{4}$	99	5.00
905	705XV	34	12	16	19 $\frac{1}{2}$	2 $\frac{1}{2}$	80	5.00
906	706XV	32	12	16	19 $\frac{1}{2}$	2 $\frac{1}{2}$	70	4.75
907	707XV	32	12	13 $\frac{1}{2}$	17	2 $\frac{3}{4}$	69	4.00
908	708X	32	16	14 $\frac{1}{2}$	18	2 $\frac{1}{2}$	68	5.75
909	709XV	30	12	16	19 $\frac{1}{2}$	2 $\frac{1}{2}$	60	4.50
910	710XV	28	12	16	19 $\frac{1}{2}$	2 $\frac{1}{2}$	53	4.25
911	711XV	28	12	13 $\frac{1}{2}$	17	2 $\frac{3}{4}$	59	3.50
912	712XV	26	12	12	15 $\frac{1}{2}$	2 $\frac{1}{2}$	40	3.50
913	713XV	24	12	12	15 $\frac{1}{2}$	2 $\frac{1}{2}$	35	3.25
914	714XV	22	12	12	15 $\frac{1}{2}$	2 $\frac{5}{8}$	32	3.00
915	715XV	20	12	12	15 $\frac{1}{2}$	2 $\frac{5}{8}$	27	2.75
916	716X	20	12	8	11 $\frac{1}{2}$	2 $\frac{3}{4}$	34	2.50
917	717XV	18	12	12	15 $\frac{1}{2}$	2 $\frac{5}{8}$	25	2.50
918	718	28	13 $\frac{1}{2}$	16	19 $\frac{1}{2}$	1 $\frac{3}{4}$	32	2.25
919	719X	28	13 $\frac{1}{2}$	14 $\frac{1}{2}$	18	3 $\frac{3}{4}$	26	2.25
920	720	26	13 $\frac{1}{2}$	16	19 $\frac{1}{2}$	1 $\frac{3}{4}$	28	2.25
921	721	26	13 $\frac{1}{2}$	12	15 $\frac{1}{2}$	1 $\frac{3}{4}$	26	2.25
922	722X	26	16	14 $\frac{1}{2}$	18	2 $\frac{1}{2}$	27	2.50
923	723X	24	13	12	15 $\frac{1}{2}$	1 $\frac{3}{4}$	20	2.25
924	724X	24	16	14 $\frac{1}{2}$	18	2 $\frac{1}{2}$	23	2.25
925	725X	22	13	12	15 $\frac{1}{2}$	1 $\frac{3}{4}$	18	2.00
926	726X	22	13 $\frac{1}{2}$	14 $\frac{1}{2}$	18	2 $\frac{1}{2}$	19	1.75
927	727X	20	12	12	15 $\frac{1}{2}$	1 $\frac{3}{4}$	14	1.75
928	728XV	20	10	8	11 $\frac{1}{2}$	2 $\frac{1}{8}$	16	1.75
929	729X	18	12	12	15 $\frac{1}{2}$	1 $\frac{3}{4}$	11	1.50
930	.....	15	10	4	7 $\frac{1}{2}$	1 $\frac{3}{4}$	12	1.50

No charge will be made for signal strand reels unless orders bear notation that charge should be made.

When strand reels are used for shipment of copper products, the letter "C" will be affixed to the reel number and the proper fixed charge will be made. Credit to be allowed on return as outlined at foot of page 66.

\*Price subject to change without notice.

# Hand Book of Electrical Wiring

## I N D E X

	PAGE
Comparative Sizes of Gauges.....	70
Dimensions and Weights of Pure Copper Wire.....	71
Allowable Size Variations on Bare Copper Wire.....	72
Data, Standard Annealed and Cleaned Bare Copper Cable Stranded.....	73
Stranded Copper Conductors.....	74
Stranded Flexible, Extra Flexible and Special Flexible Copper Cables.....	75
Standard Concentric Strands for Paper, Cambric and Rubber Insulated Cables.....	76
Flexible Concentric Strands for Paper, Cambric and Paper Insulated Cables.....	77
Extra Flexible Concentric Strands for Paper, Cambric and Rubber Insulated Cables....	78
Extra Flexible Compound Strands for Cambric and Rubber Insulated Cables.....	79
Special Flexible Compound Strands for Rubber Insulated Cables.....	80
Standard Pitch of Concentric Copper Strand.....	81
Tensile Strength of Pure Copper Wire in Pounds.....	81
Bare Copper Wire Table.....	81-83
Conductance and Resistance.....	84
Relative Conductivity of Pure Metals.....	84-87
Physical Properties of Copper, Aluminum, Iron and Steel Wire..	86
Temperature Effects on Resistance.....	87-89
Resistance per Mil-Foot of Pure Copper at Various Temperatures and Conductivities....	89
Allowable Carrying Capacities of Wires, in Amperes.....	90
Pounds per Mile-Ohm of Copper Wire at Various Temperatures and Conductivities....	91
Alternating Current Heating Effects.....	91
Factors to Obtain Effective Resistance from Ohmic Resistance.....	92
Measurements of Conductors.....	93
Wire Gauges .....	94
Wiring Formulae and Tables.....	94-95
Electric Wire and Cable Terminology.....	96-97
Strand .....	97-99
Electrical Units .....	100
Weights and Measures.....	101-104
Physical Data .....	105
Physical Properties of Metals.....	105
Conversion of Mils to Millimeters and Millimeters to Mils.....	106
Areas and Circumferences of Circles.....	107
Decimals of an Inch and Millimeters for each 1-64 Inch.....	107

## Comparative Sizes Wire Gauge in Decimals of an Inch

No. of Wire Gauge	American Steel & Wire Co.'s Steel Wire Gauge	American Wire Gauge (B. & S.)	Birmingham or Stubs	British Imperial Standard*	Old English or London	Paris Gauge (J. De P.)
00000	.4305	.51650	.500	.432	.....	.....
0000	.3938	.46000	.454	.400	.4540	.....
000	.3625	.40964	.425	.372	.4250	.....
00	.3310	.36480	.380	.348	.3800	(PF) .0157
0	.3065	.32486	.340	.324	.3400	(P) .0196
1	.2830	.28930	.300	.300	.3000	.0236
2	.2625	.25763	.284	.276	.2840	.0275
3	.2437	.22942	.259	.252	.2590	.0314
4	.2253	.20431	.238	.232	.2380	.0354
5	.2070	.18194	.220	.212	.2200	.0393
6	.1920	.16202	.203	.192	.2030	.0433
7	.1770	.14428	.180	.176	.1800	.0472
8	.1620	.12849	.165	.160	.1650	.0512
9	.1483	.11443	.148	.144	.1480	.0551
10	.1350	.10189	.134	.128	.1340	.0590
11	.1205	.09074	.120	.116	.1200	.0630
12	.1055	.08081	.109	.104	.1090	.0708
13	.0915	.07196	.095	.092	.0950	.0787
14	.0800	.06408	.083	.080	.0830	.0866
15	.0720	.05706	.072	.072	.0720	.0944
16	.0625	.05082	.065	.064	.0650	.1062
17	.0540	.04525	.058	.056	.0580	.1181
18	.0475	.04030	.049	.048	.0490	.1338
19	.0410	.03589	.042	.040	.0400	.1535
20	.0348	.03196	.035	.036	.0350	.1732
21	.0317	.02846	.032	.032	.0315	.1929
22	.0286	.02535	.028	.028	.0295	.2126
23	.0258	.02257	.025	.024	.0270	.2322
24	.0230	.02010	.022	.022	.0250	.2520
25	.0204	.01790	.020	.020	.0230	.2756
26	.0181	.01594	.018	.018	.0205	.2914
27	.0173	.01420	.016	.0164	.01875	.3228
28	.0162	.01264	.014	.0148	.01650	.3464
29	.0150	.01126	.013	.0136	.01550	.3700
30	.0140	.01003	.012	.0124	.01375	.3937
31	.0132	.00893	.010	.0116	.01225	.....
32	.0128	.00795	.009	.0108	.01125	.....
33	.0118	.00708	.008	.0100	.01025	.....
34	.0104	.00630	.007	.0092	.00950	.....
35	.0095	.00561	.005	.0084	.00900	.....
36	.0090	.00500	.004	.0076	.00750	.....
37	.0085	.00445	....	.0068	.00650	.....
38	.0080	.00396	....	.0060	.00575	.....
39	.0075	.00353	....	.0052	.00500	.....
40	.0070	.00314	....	.0048	.00450	.....

\*Also called English Standard Gauge. Full name is Legal Standard Wire Gauge, common designation Standard Wire Gauge, abbreviation S. W. G.

## Dimensions and Weights of Pure Copper Wire

American Wire Gauge (B. & S.)	Diameter Mils.	AREA		WEIGHT	
		Circular Mils. (d <sup>2</sup> ) 1 Mil. = .001 in.	Square Inch (d <sup>2</sup> x .7854)	Pounds per 1,000 feet	Pounds per Mile
0000	460.0	211600.	0.166190	640.	3378.
000	409.6	167772.	0.131770	507.	2678.
00	364.8	133079.	0.104520	402.	2124.
0	325.0	105625.	0.082958	319.	1685.
1	289.3	83694.	0.065733	253.	1336.
2	257.6	66358.	0.052117	201.	1059.
3	229.4	52624.	0.041331	159.	840.
4	204.3	41738.	0.032781	126.	666.
5	181.9	33088.	0.025987	100.	528.
6	162.0	26244.	0.020612	79.	419.
7	144.3	20822.	0.016354	63.	332.
8	128.5	16512.	0.012969	50.	264.
9	114.4	13087.	0.010279	39.6	209.
10	101.9	10384.	0.0081553	31.4	166.
11	90.7	8226.5	0.0064611	24.9	131.
12	80.8	6528.6	0.0051276	19.7	104.
13	72.0	5184.0	0.0040715	15.7	82.8
14	64.1	4108.8	0.0032271	12.4	65.6
15	57.1	3260.4	0.0025607	9.8	52.1
16	50.8	2580.6	0.0020268	7.8	41.2
17	45.3	2052.1	0.0016117	6.2	32.8
18	40.3	1624.1	0.0012756	4.9	25.9
19	35.9	1288.8	0.0010122	3.9	20.6
20	32.0	1024.0	0.00080425	3.1	16.4
21	28.5	812.25	0.00063794	2.46	12.97
22	25.3	640.09	0.00050273	1.94	10.22
23	22.6	510.76	0.00040115	1.54	8.15
24	20.1	404.01	0.00031731	1.22	6.45
25	17.9	320.41	0.00025165	0.969	5.12
26	15.9	252.81	0.00019856	0.764	4.04
27	14.2	201.64	0.00015837	0.610	3.22
28	12.6	158.76	0.00012469	0.480	2.53
29	11.3	127.69	0.00010029	0.386	2.04
30	10.0	100.00	0.000078540	0.302	1.596
31	8.93	79.74	0.000062631	0.241	1.273
32	7.95	63.20	0.000049639	0.191	1.009
33	7.08	50.13	0.000039369	0.152	0.800
34	6.30	39.69	0.000031173	0.120	0.634
35	5.61	31.47	0.000024718	0.095	0.502
36	5.00	25.00	0.000019635	0.0756	0.399
37	4.45	19.80	0.000015553	0.0599	0.316
38	3.96	15.68	0.000012316	0.0474	0.250
39	3.53	12.46	0.0000097868	0.0377	0.199
40	3.14	9.86	0.0000077437	0.0298	0.157

## Allowable Size Variations on Bare Copper Wire, Annealed or Hard Drawn

SIZE		ALLOWABLE DIAMETER IN INCHES		
American Wire Gauge (B. & S.)	Diameter in Inches	% Either Way	Minimum	Maximum
6-0	.5800	.35	.57797	.58203
5-0	.5165	.4	.51443	.51856
4-0	.4600	.45	.45793	.46207
3-0	.4096	.5	.40755	.41164
2-0	.3648	.5	.36297	.36662
1-0	.32486	.5	.32323	.32648
1	.2893	.5	.28785	.29074
2	.25763	.5	.25634	.25891
3	.22942	.75	.22769	.23114
4	.20431	.75	.20277	.20584
5	.18194	.75	.18057	.18330
6	.16202	.75	.16080	.16323
7	.14428	.75	.14319	.14536
8	.12849	1.00	.12720	.12977
9	.11443	1.00	.11328	.11557
10	.10189	1.00	.10087	.10290
12	.08080	1.25	.07979	.08181
14	.06408	1.25	.06327	.06488
16	.05082	1.50	.05005	.05158
18	.04030	1.50	.03969	.04090
19	.03589	1.75	.03526	.03651
20	.03196	1.75	.03140	.03251
21	.02846	1.75	.02796	.02895
22	.02534	1.75	.02489	.02578
23	.02257	2.00	.02211	.02302
24	.0201	2.00	.01969	.02050
25	.0179	2.00	.01754	.01825
26	.01594	2.00	.01562	.01625
27	.01419	2.00	.01390	.01447
28	.01264	2.00	.01238	.01289
29	.01125	2.00	.01102	.01147
30	.01002	2.50	.00976	.01027
31	.00892	3.00	.00865	.00918
32	.00795	3.00	.00771	.00818
33	.00708	3.00	.00686	.00729
34	.00630	3.50	.00607	.00652
35	.00561	4.00	.00538	.00583
36	.005	4.50	.00477	.00522
37	.00445	5.00	.00422	.00467
38	.00396	6.00	.00372	.00419
39	.00353	7.00	.00328	.00377
40	.00314	8.00	.00288	.00339

# Data Relating to Standard Annealed & Cleaned Bare Copper Cable Stranded

## Approximate Values

Circular Mils.	Number of Wires in Strand	Diameter Each Wire, Inches	Diameter of Strand, Inches	Weight per 1,000 Foot Strand, Pounds	Weight per Mile, Pounds	Area Strand Square, Inches	Resistance per 1,000 Feet at 68° F. or 20° C.
2,000,000	91	.1482	1.6302	6164.	32546.	1.56874	.00530
1,750,000	91	.1386	1.5257	5394.	28480.	1.36494	.00607
1,500,000	91	.1284	1.4124	4623.	24409.	1.17831	.00707
1,250,000	91	.1172	1.2892	3853.	20344.	.98170	.00852
1,000,000	61	.1280	1.1520	3081.	16268.	.78494	.01060
950,000	61	.1248	1.1232	2927.	15455.	.74618	.01115
900,000	61	.1215	1.0935	2773.	14641.	.70724	.01179
850,000	61	.1181	1.0629	2619.	13828.	.66852	.01247
800,000	61	.1145	1.0305	2465.	13015.	.62810	.01325
750,000	61	.1109	.9981	2311.	12202.	.58922	.01413
700,000	61	.1071	.9639	2157.	11389.	.54954	.01514
650,000	61	.1032	.9288	2003.	10576.	.51020	.01630
600,000	61	.0992	.8928	1849.	9763.	.47146	.01767
550,000	37	.1219	.8533	1694.	8944.	.43181	.01925
500,000	37	.1162	.8134	1540.	8131.	.39237	.02116
450,000	37	.1103	.7721	1386.	7318.	.35234	.02349
400,000	37	.1040	.7280	1232.	6505.	.31431	.02648
350,000	37	.0973	.6811	1078.	5692.	.27512	.03026
300,000	19	.1257	.6285	923.	4873.	.23591	.03531
250,000	19	.1147	.5738	769.	4060.	.19635	.04233
211,600	19	.1055	.5275	647.1	3416.7	.16609	.04997
167,772	19	.094	.4700	513.2	2709.7	.13187	.06293
133,079	7	.1378	.4134	405.9	2143.2	.10429	.07935
105,625	7	.1228	.3684	321.7	1698.6	.08303	.10007
83,694	7	.1093	.3279	255.2	1347.5	.06559	.12617
66,358	7	.0973	.2919	202.4	1068.7	.05205	.15725
52,624	7	.0867	.2601	160.5	847.4	.04132	.19827
41,738	7	.0772	.2316	127.3	672.1	.03276	.25000
26,244	7	.0612	.1836	80.0	422.4	.02059	.39767
16,512	7	.0485	.1458	50.3	265.6	.01298	.62686
10,384	7	.0385	.1155	31.6	166.8	.00815	1.00848
6,528	7	.0305	.0915	19.9	105.1	.00511	1.59716
4,108	7	.0242	.0726	12.5	66.0	.00322	2.54192

## Construction of Stranded Copper Conductors

To ascertain the diameter of the wires in a cable of any given capacity, divide the circular mils. capacity of the cable by the number of wires in the strand and extract the square root of the quotient. The result thus obtained gives the diameter in mils. of the wires composing the strand.

To ascertain the diameter of a concentric strand of 7, 19, 37, 61, 91, 127 or 169 wires:

- 7 wire strand, diameter equals 3 times diameter wires composing strand
- 19 wire strand, diameter equals 5 times diameter wires composing strand
- 37 wire strand, diameter equals 7 times diameter wires composing strand
- 61 wire strand, diameter equals 9 times diameter wires composing strand
- 91 wire strand, diameter equals 11 times diameter wires composing strand
- 127 wire strand, diameter equals 13 times diameter wires composing strand
- 169 wire strand, diameter equals 15 times diameter wires composing strand

The diameter of a 49-wire conductor, rope lay (7x7), equals 9 times the diameter of the individual wires, and the diameter of a conductor of 133 wires (7x19) equals 15 times the diameter of the individual wires.

To ascertain in circular mils. the capacity of a cable of which the number and diameter of the component wires are given, square the diameter (in mils.) of the individual wires and multiply the product by the number of wires in the strand.

All rules and data here given are based upon strands in which all of the individual wires are of the same size. The use of two or more different sizes of wire in the same strand complicates the subject to such an extent as to prevent giving specific instruction or rules.

## Stranded Copper Conductors

Capacity of Con- ductor, C. M.	Number of Wires in the Strand									
	7	19	37	(7x7) 49	61	91	127	(19x7) 133	169	217
	Diameter of Each Wire in the Strand in Decimal Parts of an Inch									
2,000,000	.5345	.3243	.2325	.2020	.1810	.1482	.1255	.1226	.1088	.0960
1,750,000	.5000	.3034	.2175	.1889	.1694	.1386	.1174	.1147	.1018	.0898
1,500,000	.4629	.2810	.2013	.1750	.1568	.1284	.1087	.1062	.0942	.0831
1,250,000	.4226	.2565	.1838	.1597	.1431	.1172	.0992	.0969	.0862	.0759
1,000,000	.3780	.2294	.1644	.1429	.1280	.1048	.0887	.0867	.0769	.0679
950,000	.3684	.2236	.1602	.1392	.1248	.1021	.0864	.0845	.0750	.0662
900,000	.3586	.2176	.1559	.1355	.1215	.0994	.0841	.0822	.0730	.0644
850,000	.3484	.2115	.1516	.1317	.1181	.0966	.0818	.0799	.0709	.0626
800,000	.3380	.2052	.1470	.1278	.1145	.0937	.0794	.0776	.0688	.0607
750,000	.3273	.1986	.1424	.1237	.1109	.0908	.0768	.0751	.0666	.0588
700,000	.3163	.1919	.1375	.1195	.1071	.0877	.0742	.0726	.0644	.0568
650,000	.3047	.1850	.1325	.1152	.1032	.0845	.0716	.0699	.0620	.0547
600,000	.2928	.1776	.1273	.1107	.0992	.0812	.0687	.0672	.0596	.0526
550,000	.2803	.1701	.1219	.1049	.0950	.0777	.0658	.0643	.0570	.0503
500,000	.2672	.1622	.1162	.1010	.0905	.0741	.0627	.0613	.0544	.0480
450,000	.2535	.1539	.1103	.0958	.0859	.0703	.0595	.0581	.0516	.0455
400,000	.2391	.1451	.1040	.0904	.0810	.0663	.0561	.0548	.0487	.0429
350,000	.2236	.1357	.0973	.0845	.0757	.0620	.0526	.0513	.0455	.0401
300,000	.2070	.1257	.0901	.0783	.0701	.0573	.0486	.0475	.0421	.0372
250,000	.1890	.1147	.0822	.0714	.0640	.0524	.0444	.0435	.0384	.0340
Size Am. Wire Gauge (B. & S.)										
0000	.1736	.1055	.0756	.0657	.0589	.0482	.0408	.0399	.0354	.0312
000	.1548	.0940	.0673	.0586	.0525	.0429	.0363	.0355	.0315	.0278
00	.1378	.0836	.0599	.0521	.0467	.0382	.0323	.0316	.0281	.0248
0	.1228	.0746	.0534	.0464	.0416	.0340	.0288	.0282	.0250	.0221
1	.1093	.0663	.0475	.0413	.0370	.0303	.0252	.0251	.0222	.0196
2	.0973	.0592	.0423	.0369	.0329	.0269	.0228	.0224	.0199	.0175
3	.0867	.0526	.0377	.0327	.0294	.0240	.0203	.0199	.0176	.0156
4	.0772	.0468	.0335	.0290	.0261	.0214	.0179	.0177	.0157	.0139
5	.0687	.0417	.0299	.0259	.0233	.0190	.0161	.0158	.0140	.0121
6	.0612	.0372	.0266	.0231	.0207	.0169	.0143	.0141	.0125	.0110
8	.0485	.0293	.0211	.0184	.0164	.0135	.0114	.0111	.0098	.0087
10	.0385	.0233	.0168	.0145	.0129	.0106	.0090	.0088	.0078	.0069
12	.0305	.0185	.0133	.0116	.0104	.0085	.0072	.0070	.0062	.0055
14	.0242	.0147	.0105	.0091	.0082	.0069	.0057	.0056	.0049	.0043

**CIRCULAR MIL.**—A unit of area employed in measuring the cross-section of wires, equal, approximately, to 0.7854 square mils.; the area of a circle one mil. in diameter.

**EXAMPLE:** The circular millage measurement of 4/0 American Wire Gauge (B. & S.) is the square of the diameter in mils.—i.e., .460 x .460 = 211,600 C.M.

**SQUARE MIL.**—A unit of area employed in measuring the areas of cross-section of wires, equal to .000001 square inch; a unit of area equal to 1.2732 circular mils.

## Stranded, Flexible, Extra Flexible and Special Flexible (Weatherproof, Paper, Cambric and Rubber) Copper Cables

The following tables, Nos. E. C. E. 623 to 628, represent our standard practice for stranding of various kinds of cables. The number of wires in the strand determine the flexibility of the cable and must be taken into consideration in figuring a price.

If more wires are desired on compound strands than mentioned in tables E. C. E. 627 and 628 or more wires than set forth on concentric strands in table E. C. E. 626 the cable will have to be treated entirely special and special prices obtained.

The terms flexible, extra flexible and special flexible are comparative only. To avoid possibility of error all orders and inquiries for cables more flexible than standard should state the number of wires desired.

### Standard Strands for Weatherproof Cables

Table E. C. E. 623, 1921

Size of Conductor C. M.	No. of Wires	Diam. of Individual Wire In Inches	O. D. of Strand In Inches
2,000,000	91	.1482	1.6302
1,750,000	91	.1386	1.5246
1,500,000	91	.1284	1.4124
1,250,000	91	.1172	1.2892
1,000,000	61	.1280	1.1520
950,000	61	.1248	1.1232
900,000	61	.1215	1.0935
850,000	61	.1181	1.0629
800,000	61	.1145	1.0305
750,000	61	.1109	.9981
700,000	61	.1071	.9639
650,000	61	.1032	.9288
600,000	61	.0992	.8928
550,000	61	.0950	.8550
500,000	37	.1162	.8134
450,000	37	.1103	.7721
400,000	37	.1040	.7280
350,000	37	.0973	.6811
300,000	19	.1257	.6285
250,000	19	.1147	.5735
American Wire Gauge (B. & S.)			
0000	19	.1055	.5275
000	19	.0940	.4700
00	7	.1378	.4134
0	7	.1228	.3684
1	7	.1093	.3279
2	7	.0973	.2919
3	7	.0867	.2601
4	7	.0772	.2316
5	7	.0687	.2061
6	7	.0612	.1836
8	7	.0485	.1455
10	7	.0385	.1155
12	7	.0306	.0915
14	7	.0243	.0726

## Standard Concentric Strands for Paper, Cambric and Rubber Insulated Cables

Table E. C. E. 624, 1921

Size of Conductor C. M.	No. of Wires	Diam. of Individual Wire In Inches	O. D. of Strand In Inches
2,000,000	127	.1255	1.6315
1,750,000	127	.1174	1.5262
1,500,000	91	.1284	1.4124
1,250,000	91	.1172	1.2892
1,000,000	61	.1280	1.1520
950,000	61	.1248	1.1232
900,000	61	.1215	1.0935
850,000	61	.1181	1.0629
800,000	61	.1145	1.0305
750,000	61	.1109	.9981
700,000	61	.1071	.9639
650,000	61	.1032	.9288
600,000	61	.0992	.8928
550,000	61	.0950	.8550
500,000	37	.1162	.8134
450,000	37	.1103	.7721
400,000	37	.1040	.7280
350,000	37	.0973	.6811
300,000	37	.0901	.6307
250,000	37	.0822	.5754
American Wire Gauge (B. & S.)			
0000	19	.1055	.5275
000	19	.0940	.4700
00	19	.0836	.4180
0	19	.0746	.3730
1	19	.0663	.3315
2	7	.0973	.2919
3	7	.0867	.2601
4	7	.0772	.2316
5	7	.0687	.2061
6	7	.0612	.1836
8	7	.0485	.1455
10	7	.0385	.1155
12	7	.0305	.0915
14	7	.0242	.0726

## Flexible Concentric Strands for Paper, Cambric and Rubber Insulated Cables

Table E. C. E. 625, 1921

Size of Conductor C. M.	No. of Wires	Diam. of Individual Wire in Inches	O. D. of Strand in Inches
2,000,000	169	.1088	1.6320
1,750,000	169	.1018	1.5270
1,500,000	127	.1087	1.4132
1,250,000	127	.0992	1.2896
1,000,000	91	.1048	1.1528
950,000	91	.1021	1.1231
900,000	91	.0994	1.0934
850,000	91	.0966	1.0626
800,000	91	.0937	1.0307
750,000	91	.0908	.9988
700,000	91	.0877	.9647
650,000	91	.0845	.9295
600,000	91	.0812	.8932
550,000	91	.0777	.8547
500,000	61	.0905	.8145
450,000	61	.0859	.7731
400,000	61	.0810	.7290
350,000	61	.0757	.6813
300,000	61	.0701	.6309
250,000	61	.0640	.5760
American Wire Gauge (B. & S.)			
0000	37	.0756	.5292
000	37	.0673	.4711
00	37	.0599	.4193
0	37	.0534	.3738
1	37	.0475	.3325
2	19	.0592	.2950
3	19	.0526	.2630
4	19	.0468	.2340
5	19	.0417	.2085
6	19	.0372	.1860
8	19	.0293	.1465
10	19	.0233	.1165
12	19	.0185	.0930
14	19	.0147	.0740

## Extra Flexible Concentric Strands for Paper, Cambric and Rubber Insulated Cables

Table E. C. E. 626, 1921

Size of Conductor C. M.	No. of Wires	Diam. of Individual Wire in Inches	O. D. of Strand in Inches
2,000,000	217	.096	1.6320
1,750,000	217	.0898	1.5266
1,500,000	169	.0942	1.4130
1,250,000	169	.0862	1.2930
1,000,000	127	.0887	1.1531
950,000	127	.0864	1.1232
900,000	127	.0841	1.0933
850,000	127	.0818	1.0634
800,000	127	.0794	1.0322
750,000	127	.0768	.9984
700,000	127	.0742	.9646
650,000	127	.0716	.9308
600,000	127	.0687	.8931
550,000	127	.0658	.8554
500,000	91	.0741	.8151
450,000	91	.0703	.7733
400,000	91	.0663	.7293
350,000	91	.0620	.6820
300,000	91	.0573	.6303
250,000	91	.0524	.5764
American Wire Gauge (B. & S.)			
0000	61	.0589	.5301
000	61	.0525	.4725
00	61	.0467	.4203
0	61	.0416	.3744
1	61	.0370	.3330
2	37	.0423	.2961
3	37	.0377	.2639
4	37	.0335	.2345
5	37	.0299	.2093
6	37	.0266	.1862
8	37	.0211	.1477
10	37	.0168	.1176
12	37	.1033	.0931
14	37	.0105	.0735

## Extra Flexible Compound Strands for Cambric and Rubber Insulated Cables

Table E. C. E. 627, 1921

Size of Conductor C. M.	No. of Wires	Diam. of Individual Wire In Inches	Make-up	O. D. of Strand In Inches
2,000,000	889	.048	127x7	1.872
1,750,000	889	.045	127x7	1.755
1,500,000	637	.048	91x7	1.584
1,250,000	637	.045	91x7	.485
1,000,000	427	.048	61x7	1.296
950,000	427	.0472	61x7	1.2744
900,000	427	.0459	61x7	1.2403
850,000	427	.0446	61x7	1.2042
800,000	427	.0433	61x7	1.1691
750,000	427	.042	61x7	1.134
700,000	427	.0405	61x7	1.0935
650,000	427	.0390	61x7	1.053
600,000	427	.0375	61x7	1.0125
550,000	427	.0359	61x7	.9693
500,000	259	.0449	37x7	.9429
450,000	259	.042	37x7	.882
400,000	259	.040	37x7	.840
350,000	259	.0378	37x7	.7938
300,000	259	.034	37x7	.714
250,000	259	.032	37x7	.672
American Wire Gauge (B. & S.)				
0000	133	.0399	19x7	.5985
000	133	.0356	19x7	.5340
00	133	.0317	19x7	.4755
0	133	.0284	19x7	.4260
1	133	.0251	19x7	.3765
2	49	.0369	7x7	.3321
3	49	.0327	7x7	.2943
4	49	.0290	7x7	.261
5	49	.0259	7x7	.2331
6	49	.0231	7x7	.2079
8	49	.0184	7x7	.1656

## Special Flexible Compound Strands for Rubber Insulated Cables

Table E. C. 628, 1921

Size of Conductor C. M.	No. of Wires	Diam. of Individual Wire In Inches	Make-up	O. D. of Strand In Inches
2,000,000	1183	.0419	169x7	1.8855
1,750,000	1183	.038	169x7	1.710
1,500,000	889	.041	127x7	1.599
1,250,000	889	.038	127x7	1.482
1,000,000	637	.0396	91x7	1.3068
950,000	637	.0386	91x7	1.2738
900,000	637	.0376	91x7	1.2408
850,000	637	.0365	91x7	1.2045
800,000	637	.0354	91x7	1.1682
750,000	637	.034	91x7	1.122
700,000	637	.0331	91x7	1.0923
650,000	637	.0319	91x7	1.0527
600,000	637	.0307	91x7	1.0131
550,000	637	.0294	91x7	.9702
500,000	427	.035	61x7	.945
450,000	427	.032	61x7	.864
400,000	427	.031	61x7	.837
350,000	427	.0282	61x7	.7614
300,000	427	.0261	61x7	.7047
250,000	427	.0241	61x7	.6507
American Wire Gauge (B. & S.)				
0000	259	.0290	37x7	.609
000	259	.0255	37x7	.5355
00	259	.0227	37x7	.4767
0	259	.0203	37x7	.4263
1	259	.0180	37x7	.378
2	133	.0224	19x7	.3360
3	133	.0199	19x7	.2985
4	133	.0177	19x7	.2655

Standard Pitch of Concentric Copper Strand

Number of Wires in Strand	Number in Outside Layer	Per Cent Take-up Each Layer	Per Cent Take-up of Whole Strand	Approximate Diameters Pitch	Angle of Wire	Cosine of Angle	Approximate Weight per 100,000 Circular Mills per 1,000 Feet Strand
1	..	....	....	....	....	....	302.7058
7	6	0.97	0.83	15	8°-0'	.9902	305.218
19	12	2.63	1.97	11	13°-0'	.9744	308.669
37	18	2.63	2.29	12	13°-0'	.9744	309.638
61	24	2.63	2.42	12	13°-0'	.9744	310.031
91	30	2.63	2.49	12½	13°-0'	.9744	310.243
127	36	2.63	2.53	12½	13°-0'	.9744	310.361
169	42	2.63	2.55	12½	13°-0'	.9744	310.425
217	48	2.63	2.57	12½	13°-0'	.9744	310.485
7x7=49	6 Wires	.097	....	15	8°-0'	.9903	316.214
Rope Strand	6 Strands	1.54	2.16	12	10°-0'	.9848	.....

Tensile Strength of Pure Copper Wire in Pounds

American Wire Gauge (B.&S.)	Hard Drawn		Annealed		American Wire Gauge (B. & S.)	Hard Drawn		Annealed	
	Actual	Average per Square Inch	Actual	Average per Square Inch		Actual	Average per Square Inch	Actual	Average per Square Inch
0000	8260.	49,700	5320.	32,000	7	1050.	64,200	556.	34,000
000	6550.	49,700	4220.	32,000	8	843.	65,000	441.	34,000
00	5440.	52,000	3340.	32,000	9	678.	66,000	350.	34,000
0	4530.	54,600	2650.	32,000	10	546.	67,000	277.	34,000
1	3680.	56,000	2100.	32,000	12	343.	67,000	174.	34,000
2	2970.	57,000	1670.	32,000	14	219.	68,000	110.	34,000
3	2380.	57,600	1323.	32,000	16	138.	68,000	68.9	34,000
4	1900.	58,000	1050.	32,000	18	86.7	68,000	43.4	34,000
5	1580.	60,800	884.	34,000	19	68.8	68,000	34.4	34,000
6	1300.	63,000	700.	34,000	20	54.7	68,000	27.3	34,000

Bare Copper Wire Table

The data from which these tables have been computed are as follows: Matthiessen's standard resistivity, Matthiessen's temperature coefficients, specific gravity of copper=8.89. Resistance in terms of the international ohm.

American Wire Gauge (B. & S.)	Diameter of Wire			Cross-sectional Area		
	In Inches	Allowable Variation in Per Cent Either Way	In Millimeters	Circular Mills (d²) d=.001 Inch	Square Inch (d²x.7854)	Square Millimeter
0000	.4600	.45	11.680	211600.	.166190	107.219
000	.4096	.50	10.400	167772.	.131770	85.011
00	.3648	.50	9.266	133079.	.104520	67.432
0	.3250	.50	8.255	105625.	.082958	53.521
1	.2893	.50	7.348	83694.	.065733	42.408
2	.2576	.50	6.543	66358.	.052117	33.624
3	.2294	.75	5.827	52624.	.041331	26.665
4	.2043	.75	5.189	41738.	.032781	21.149
5	.1819	.75	4.620	33088.	.025987	16.766
6	.1620	.75	4.115	26244.	.020612	13.298
7	.1443	.75	3.665	20822.	.016354	10.550
8	.1285	1.00	3.264	16512.	.012969	8.3666
9	.1144	1.00	2.906	13087.	.010279	6.6313
10	.1019	1.00	2.588	10384.	.0081553	5.2614
11	.0907	1.00	2.304	8226.5	.0064611	4.1684
12	.0808	1.25	2.052	6528.6	.0051276	3.3081
13	.0720	1.25	1.829	5184.0	.0040715	2.6267
14	.0641	1.25	1.628	4108.8	.0032271	2.0819
15	.0571	1.25	1.450	3260.4	.0025607	1.6520
16	.0508	1.50	1.290	2580.6	.0020268	1.3076

Bare Copper Wire Table—Continued

American Wire Gauge (B. & S.)	Diameter of Wire			Cross-sectional Area		
	In Inches	Allowable Variation in Per Cent Either Way	In Millimeters	Circular Mils (d <sup>2</sup> ) d = .001 Inch	Square Inch (d <sup>2</sup> × .7854)	Square Millimeter
17	.0453	1.50	1.151	2052.1	.0016117	1.0398
18	.0403	1.50	1.024	1624.1	.0012756	.82294
19	.0359	1.75	.9119	1288.8	.0010122	.65304
20	.0320	1.75	.8128	1024.0	.00080425	.51887
21	.0285	1.75	.7239	812.25	.00063794	.41157
22	.0253	1.75	.6426	640.09	.00050273	.32434
23	.0226	2.00	.5740	510.76	.00040115	.25880
24	.0201	2.00	.5105	404.01	.00031731	.20471
25	.0179	2.00	.4547	320.41	.00025165	.16235
26	.0159	2.00	.4039	252.81	.00019856	.12810
27	.0142	2.00	.3607	201.64	.00015837	.10217
28	.0126	2.00	.3200	158.76	.00012469	.08044
29	.0113	2.00	.2870	127.69	.00010029	.06470
30	.0100	2.50	.2540	100.00	.000078540	.05067
31	.00893	3.00	.2268	79.74	.000062631	.04040
32	.00795	3.00	.2019	63.20	.000049639	.03202
33	.00708	3.00	.1798	50.13	.000039369	.02540
34	.00630	3.50	.1600	39.69	.000031173	.02011
35	.00561	4.00	.1425	31.47	.000024718	.01594
36	.00500	4.50	.1270	25.00	.000019635	.01266
37	.00445	5.00	.1130	19.80	.000015553	.01003
38	.00396	6.00	.1006	15.68	.000011236	.00794
39	.00353	7.00	.08966	12.46	.0000097868	.00631
40	.00314	8.00	.07976	9.86	.0000077437	.00499

Bare Copper Wire Table—Continued

Giving dimensions, weights, lengths and resistances of bare round solid wires, Matthiessen's Standard of Conductivity. While these values are theoretically correct, slight variation should be expected in practice. Specific gravity in copper 8.89.

American Wire Gauge (B. & S.)	Pounds per		Ohms per			Feet per	
	1000 Feet	Mile	Pound at 20° C. 68° F.	1000 Feet at 20° C. 68° F.	1000 Feet at 50° C. 122° F.	Pound	Ohm at 20° C. 68° F.
0000	639.8	3378	.0000764	.04893	.05467	1.563	20,440
000	507.3	2678	.0001215	.06170	.06893	1.971	16,210
00	402.4	2124	.0001931	.07780	.08692	2.485	12,850
0	319.4	1686	.0003071	.09811	.1096	3.131	10,190
1	253.0	1336	.0004883	.1237	.1382	3.952	8,083
2	200.6	1059	.0007765	.1560	.1743	4.984	6,410
3	159.1	840.1	.001235	.1967	.2198	6.285	5,084
4	126.2	666.3	.001963	.2480	.2771	7.924	4,031
5	100.0	528.2	.003122	.3128	.3495	9.996	3,197
6	79.35	419.0	.004963	.3944	.4406	12.60	2,535
7	62.96	332.4	.007892	.4973	.5556	15.88	2,011
8	49.92	263.6	.01255	.6271	.7007	20.03	1,595
9	39.57	208.9	.01995	.7908	.8835	25.27	1,265
10	31.30	165.8	.03173	.9972	1.114	31.85	1,003
11	24.87	131.3	.05045	1.257	1.405	40.21	795.3
12	19.74	104.2	.08022	1.586	1.771	50.66	630.7
13	15.67	82.76	.1276	1.999	2.234	63.80	500.1
14	12.42	65.59	.2028	2.521	2.817	80.50	396.6
15	9.858	52.05	.3225	3.179	3.552	101.4	314.5
16	7.802	41.20	.5128	4.009	4.479	128.2	249.4

## Bare Copper Wire Table—Continued

American Wire Gauge (B. & S.)	Pounds per		Ohms per			Feet per	
	1000 Feet	Mile	Pounds at 20° C. 68° F.	1000 Feet at 20° C. 68° F.	1000 Feet at 50° C. 122° F.	Pound	Ohm at 20° C. 68° F.
17	6.204	32.76	8153	5.055	5.648	161.2	197.8
18	4.910	25.93	1,296	6.374	7.122	203.7	156.9
19	3.897	20.57	2,061	8.038	8.980	256.6	124.4
20	3.096	16.35	3,278	10.14	11.32	323.0	98.66
21	2.456	12.97	5,212	12.78	14.28	407.2	78.24
22	1.935	10.22	8,287	16.12	18.01	516.7	62.05
23	1.544	8.154	13.18	20.32	22.71	647.6	49.21
24	1.222	6.450	20.95	25.63	28.63	818.7	39.02
25	.9688	5.115	33.32	32.31	36.10	1,034	30.95
26	.7644	4.036	52.97	40.75	45.52	1,308	24.54
27	.6097	3.219	84.23	51.38	57.40	1,640	19.46
28	.4800	2.534	133.9	64.79	72.39	2,083	15.43
29	.3861	2.038	213.0	81.70	91.28	2,590	12.24
30	.3023	1.596	338.6	103.0	115.1	3,307	9.707
31	.2411	1.273	538.4	129.9	145.1	4,148	7.698
32	.1911	1.009	856.8	161.8	183.0	5,233	6.105
33	.1516	.8002	1,361	206.6	230.8	6,598	4.841
34	.1200	.6336	2,165	260.5	291.0	8,333	3.839
35	.09515	.5024	3,441	328.4	366.9	10,509	3.045
36	.07559	.3991	5,473	414.2	462.7	13,230	2.414
37	.05987	.3161	8,702	522.2	583.5	16,702	1.951
38	.04741	.2503	13,870	658.5	735.7	21,091	1.519
39	.03768	.1989	22,000	830.4	927.7	26,543	1.204
40	.02981	.1574	34,980	1047.0	1170.0	33,546	0.955

Conductance and Resistance

Electrical energy is always transferred from the generating source to the receiving device through, or by means of, some form of *conductor*. This is one of the three necessary parts of any electrical circuit. With the various kinds of metallic conductors we shall be chiefly concerned in this catalogue.

Electricity may be transmitted through any substance, though in widely varying degrees. The following table gives a list of materials which are arranged approximately in order of their conducting powers:

Conductors	Non-Conductors or Insulators	
All metals Well-burned charcoal Plumbago Acid solutions Metallic ores Living vegetable substances Moist earth Water	Dry air Shellac Paraffin Resins Sulphur Wax Glass Mica	Ebonite Gutta-percha India rubber Silk Dry paper Dry leather Porcelain Oils

The conducting power of any substance depends largely upon its physical state. For instance, the conductivity of air decreases very rapidly as its pressure increases, while rarefied air makes a good conductor of electricity. The conductivity of all substances materially alters with change of temperature.

The number of substances which are used for conductors of electricity in commercial work is, however, limited to three of the useful metals, copper, iron and aluminum. Of these, the first is pre-eminently the best, while next in order come aluminum and iron. Pure copper possesses many physical properties of great engineering value in addition to that of its high conductivity. It has to a very high degree the qualities of malleability and ductility which make it an ideal metal for wire drawing. Its strength and hardness are greater than that of any other metal except iron and steel. It has the power of resisting oxidation, it takes a fine polish, is easily worked, and can be forged more easily than iron.

The precious metals, platinum, gold and silver, are used as conductors only to a limited extent in laboratories and for scientific purposes. A list of the common metals, arranged in order of their relative conducting properties, is given in the following table:

Relative Conductivity of Pure Metals

Matthiessen's Standard

Metals	Relative Conductivity	Metals	Relative Conductivity
Silver, annealed	108	Iron, wrought	17.6
Copper, annealed	102	Nickel	13.0
Gold, annealed	73	Tin	12.0
Aluminum, annealed	63	Lead	8.0
Zinc	28	Mercury	1.7

Since the conductivity of any one wire will in general differ from that of any other, it becomes necessary in comparing or specifying wires to refer to some standard or system of units. We cannot describe anything except by comparing it with some standard which is recognized by and familiar to all. The conducting power of a substance is usually expressed in terms of electric *resistance* rather than in terms of conductivity. The resistance of a wire is the reciprocal of its conductivity. A wire that is high in conductivity is low in resistance and vice versa. Resistance is that property of a conductor by virtue of its form and molecular structure which modifies the strength of current flowing through it. It is an inherent property of all electrical conductors; even the best conductors possess appreciable resistance.

The commercial standard of conductivity in this country is the one established by Dr. Matthiessen in 1861. It is that of a piece of supposedly pure copper wire of constant cross-section having the following specifications:

Specific gravity, 8.89.

Length, 1 meter or 39.3704 inches.

Weight, 1 gram or 15.432 grains.

Resistance, 0.141729 ohms at 0° C.

Specific resistance, 1.594 microhms per cubic centimeter, or

Specific resistance, 0.6276 microhms per cubic inch at 0° C.

Much of the copper now being made is higher in conductivity than Dr. Matthiessen's standard by one or two per cent., owing to improved methods of refining copper. It is usual, however, to specify that soft drawn copper shall have 98 per cent. conductivity and hard drawn copper 97 per cent. of Matthiessen's standard.

The practical unit of resistance is the *International Ohm*, which is the resistance offered to an unvarying electric current by a column of pure mercury at a temperature of melting ice, 14.4521 grams (0.51 ounces) in mass, of a constant cross-sectional area, and 106.3 centimeters (41.85 inches) in length. To obtain a concrete idea of this unit it may be remembered that a copper wire having a diameter of one tenth of an inch, has at 68° F. a resistance of approximately one ohm per thousand feet, or 5.28 ohms per mile.

Resistance varies greatly with different metals and is in general less for a pure metal than for any of its alloys. Its value will in every case depend upon the relation of three factors. The length of the wire, its cross-sectional area, and the nature or chemical composition of the metal, all of which vary the temperature. Increasing or decreasing the length ( $L$ ) of any conductor will increase or decrease the resistance ( $R$ ) of the conductor in direct proportion. Increasing or decreasing its sectional area ( $A$ ) will inversely affect its resistance, that is, as the section of the conductor increases the resistance becomes proportionately less, and conversely. The term conductor as used in this connection should be taken in its broadest sense, meaning the whole length of any circuit or any portion of a circuit under consideration, whether it be in a straight line or wound in a coil.

For example: One mile of any given wire will have twice the resistance of one-half mile of the same wire, or 5.28 times the resistance of 1,000 feet. Again, if we have two wires of equal length, one of which has a sectional area five times as great as that of the other, then, assuming uniform quality and treatment, the

electrical resistance of the larger wire will be one-fifth that of the smaller, and as the weight per unit length varies directly as the sectional area, it follows that the resistance of a wire weighing, for example, 500 pounds per mile, will equal one-fifth the resistance of a wire weighing 100 pounds per mile, assuming uniform quality and treatment as before.

Algebraically, these relations may be expressed thus:

$$R = K \frac{L}{A}$$

Where (K) is a constant for any metal and represents its *resistivity* or *specific resistance*.

Resistivity, a factor depending only on the material or structure of the metal as compared with pure copper as unity, may be expressed in a number of different ways, all being equivalent to the resistance of some unit of cross-section. This unit may be expressed either in linear dimensions or as a combination of weight and dimensions. It may represent the resistance measured between opposite faces of

Physical Properties of Copper, Aluminum, Iron and Steel Wire

Physical Properties		Copper		Aluminum 99 Per Cent. Pure	Iron (Ex. B. B.)	Steel (Siemens Martin)
		Annealed	Hard Drawn			
Conductivity, Matthiessen's Standard Ohms per mil-foot at 68° F. = 20° C. (K) .....		99 to 102	96 to 99	61 to 63	16.8	8.7
Ohms per mile at 68° F. = 20° C. ....		10.36	10.57	16.7	62.9	119.7
		54,600	55,700	88,200	332,000	632,000
		cir. mils	cir. mils	cir. mils	cir. mils	cir. mils
Pounds per mile-ohm at 68° F. = 20° C. ....		875	896	424.0	4700	8900
Temperature co-efficient per degrees F. Mean values .....		.00233	.00233	.0022	.0028	.....
Temperature co-efficient per degrees C. Mean values .....		.0042	.0042	.0040	.0050	.....
Specific gravity. Mean values. ....		8.89	8.94	2.68	7.77	7.85
Pounds per 1,000 feet per circular mil.		.003027	.003049	.000909	.002652	.002671
Weight, in pounds per cubic inch. ....		.320	.322	.0967	.282	.283
Specific heat. Mean values. ....		.093	.093	.214	.113	.117
Melting point in degrees F. Mean values .....		2012	2012	1157	2975	2480
Melting point in degrees C. Mean values .....		1100	1100	625	1635	1360
Mean co-efficient of linear expansion. Degrees F. ....		.00000950	.00000950	.00001285	.00000673	.00000662
Mean co-efficient of linear expansion. Degrees C. ....		.0000171	.0000171	.0000231	.000120	.000118
SOLID WIRE Pounds per square inch	Tensile strength. ....	30,000	45,000	20,000	50,000	100,000
		to	to	to	to	to
		42,000	68,000	35,000	55,000	120,000
	Elastic limit. ....	6,000	25,000	14,000	25,000	50,000
		to	to		to	to
		16,000	45,000		30,000	72,000
	Modulus of elasticity	7,000,000	13,000,000	10,500,000	22,000,000	22,000,000
		to	to	to	to	to
		17,000,000	18,000,000	11,500,000	27,000,000	27,000,000
CONCENTRIC STRAND Pounds per square inch	Tensile strength. ....	29,000	43,000	25,800	.....	98,000
		to	to			to
		37,000	65,000			118,000
	Elastic limit. ....	5,800	23,000	13,800	.....	45,000
		to	to			to
		14,800	42,000			55,000
	Modulus of elasticity	5,000,000	12,000,000	Approx. 10,000,000	.....	16,000,000
		to	to			to
		12,000,000	14,000,000			22,000,000

a unit cube of the metal. Or, another and more common way of expressing resistivity is in terms of *ohms per mil-foot*, meaning the resistance of a round wire one foot long, having a diameter of one mil or .001 inch and an area of one circular mil. With this unit, the resistance of any wire is found by multiplying its length (L) by its resistivity (K see page 86) in ohms per mil-foot and dividing this product by the section area expressed in circular mils.

For telephone and telegraph conductors it is customary to use still another unit of resistivity—*weight per mile-ohm*. This is the weight of a conductor one mile in length, which has a resistance of one ohm. It equals the product of the resistance per mile and the weight per mile. However great may be the variation in weight of wires of different sizes, the variation in resistance is equally great inversely, and so the balance is preserved.

To illustrate: If the mile-ohm be 5,000, the resistance of a wire weighing 1000 pounds per mile will be 5 ohms, while a similar wire weighing 5 pounds per mile will have a resistance of 1,000 ohms. This method of expressing resistance is more direct than the others, which require interpretation before the results may be used in any calculation. Values for these various units will be found tabulated on page 86.

### Temperature Effects on Resistance

The question of temperature bears an important part in all tests and calculations of electrical conductors, as the resistance varies directly with temperature. The resistance of copper wire increases about twenty-three one-hundredths and that of iron wire about twenty-eight one-hundredths per cent. for each additional degree F.

Dr. Matthiessen, while experimenting with copper conductors, derived the following formula for the change of resistance with temperature in copper wire:

$$R_t = R_0 (1 + .00387t + .0000059t^2)$$

Later experiments have shown that for practical engineering purposes all terms below the second may be dropped, and that the above equation for temperature changes in copper wire may now be written:

$$R_t = R_0(1 + .0042t) \text{ for } t \text{ in degrees C. or}$$

$$R_t = R_0(1 + .0023t) \text{ for } t \text{ in degrees F.}$$

Where  $R_0$  = Resistance at 0° C.

$R_t$  = Resistance at any temperature  $t^\circ$ .

The general equation for any conductor is usually written:

$$R_t = R_0(1 + a t), \text{ where}$$

$a$  is called the *temperature coefficient* of the conductor. These coefficients vary considerably with the purity of metals, and they change slightly even in the purest

Metals	Centigrade	Fahrenheit
Aluminum	.0040	.0022
Copper, annealed	.0042	.0023
Gold	.0038	.0021
Mercury	.0007	.0004
Platinum	.0025	.0014
Silver, annealed	.0040	.0022
Soft iron	.0050	.0028
Tin	.0044	.0025
Zinc	.0041	.0023

metals. The average values of the temperature coefficient, shown on page 89, have been found experimentally, at 0° C.

For convenience in determining the resistivity of copper conductors at various temperatures, we give on page 89 the resistance per mil-foot at temperatures ranging from -10° C. to 45° C. at 97 per cent., 98 per cent. and at 100 per cent. conductivity Matthiessen's standard. We also give, on page 91, the weight per mile-ohm at various temperatures and conductivities within practical limits.

If a continuous current of electricity flows through any conductor, a certain definite portion of the electrical energy supplied to the conductor will be required to overcome its resistance and transmit the current between any two points in the conductor. This energy of transmission as it is called, is never lost, but is transformed into heat energy. Heat will be developed whenever any electric current flows through any conductor, or part of conductor, the amount of heat being directly proportional to the resistance of the conductor and to the square of the current flowing. The amount of heat measured in calories will equal

$$H = 0.24 I^2 R t$$

Where H represents calories of heat produced

I represents current in amperes

R represents resistance of conductor in ohms, and

t represents time in seconds that the current flows.

If heat be developed in the conductor faster than it can be dissipated from the surface by radiation and convection the temperature will rise. The allowable safe temperature rise is one of the limiting features of the current carrying capacity of any conductor. Since the rate at which heat will be dissipated from any conductor will depend upon many conditions, such as its size and structure, the kind and amount of insulation, if any, and its location with respect to other bodies, it is not possible to give any general definite rule for carrying capacity that will be true for all conditions. The following empirical formula\* will give approximate values for the current I flowing through a solid conductor, or through *each conductor* of a multiple conductor cable which will cause a rise in temperature of t degrees C.

$$I = C \sqrt{t \frac{d^3}{K}}$$

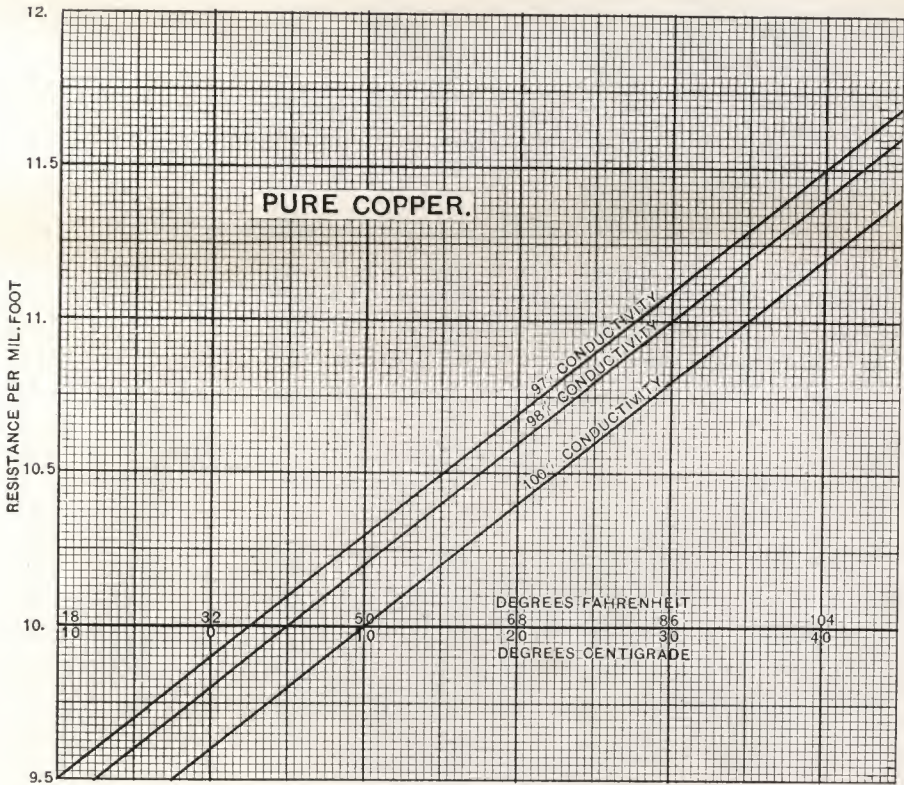
Location and Kind of Conductor	Values of Constant C in Ex- $\sqrt{t \frac{d^3}{K}}$ pression C	
	Solid Conductor	Stranded Con- ductor
Bare overhead wires out of doors.....	1250	1100
Bare wires in doors, exposed.....	660	610
Single conductor rubber covered cable in still air.....	530	490
Single conductor rubber covered lead sheathed cable in underground single duct conduit.....	530	490
Single conductor paper covered lead sheathed cable in underground single duct conduit.....	470	430
Three-conductor rubber covered lead sheathed cable in underground single duct conduit.....	400	370
Three-conductor paper covered lead sheathed cable in underground single duct conduit.....	350	320

\*Taken by permission from Foster's Electrical Engineer's Pocket Book published by D. Van Nostrand Company, New York.

In this,  $d$  represents the diameter of the bare wire or stand,  $K$  is the resistance per mil-foot of the wire at allowable elevated temperature  $t$  taken from the curves given on this page, and  $C$  is a constant having the following values for different conditions.

## Resistance per Mil-Foot of Pure Copper at Various Temperatures and Conductivities

Values of  $K$  in expression  $C \sqrt{t \frac{d^3}{K}}$



The heat radiating surface of any conductor varies as the diameter of the conductor, while the current carrying capacity, depending on the number of circular mils, will vary as the square of the diameter. In consequence, the current density in large conductors will be less than in small conductors for an equal temperature rise. It has been found impracticable on this account to use insulated conductors larger than 2,000,000 c. m., except in special cases.

# Allowable Carrying Capacities of Wires, in Amperes

N. E. C. Standard. For Inside Work

American Wire Gauge (B. & S.)	Capacity Circular Mils.	Rubber	Varnished Cambric	Other Insulation
18	1,624	3	....	5
16	2,583	6	....	10
14	4,107	15	18	20
12	6,530	20	25	25
10	10,380	25	30	30
8	16,510	35	40	50
6	26,250	50	60	70
5	33,100	55	65	80
4	41,740	70	85	90
3	52,630	80	95	100
2	66,370	90	110	125
1	83,690	100	120	150
0	105,500	125	150	200
00	133,100	150	180	225
000	167,800	175	210	275
0000	211,600	225	270	325
....	250,000	250	300	350
....	300,000	275	330	400
....	350,000	300	360	450
....	400,000	325	390	500
....	500,000	400	480	600
....	600,000	450	540	680
....	700,000	500	600	760
....	800,000	550	660	840
....	900,000	600	720	920
....	1,000,000	650	780	1,000
....	1,100,000	690	830	1,080
....	1,200,000	730	880	1,150
....	1,300,000	770	920	1,220
....	1,400,000	810	970	1,290
....	1,500,000	850	1,020	1,360
....	1,600,000	890	1,070	1,430
....	1,700,000	930	1,120	1,490
....	1,800,000	970	1,160	1,550
....	1,900,000	1,010	1,210	1,610
....	2,000,000	1,050	1,260	1,670

Drop of potential is not taken into consideration in the above table. These amperages for rubber-covered wires are adopted because to exceed them may cause gradual deterioration of the insulation even though the chance of ignition from overheating may be small.

Wires smaller than No. 14 should not be used except as prescribed in Underwriters' rules.

For aluminum wire the carrying capacity of any given size should be taken as 84 per cent. of the value given in the above table.

## Pounds per Mile-Ohm of Copper Wire at Various Temperatures and Conductivities

Per Cent Conductivity Matthiessen's Standard	Pounds per Mile-Ohm				Per Cent Conductivity Matthiessen's Standard	Pounds per Mile-Ohm			
	At 32° F. 0° C.	At 60° F. 15.6° C.	At 68° F. 20° C.	At 104° F. 40° C.		At 32° F. 0° C.	At 60° F. 15.6° C.	At 68° F. 20° C.	At 104° F. 40° C.
96.0	841.9	893.4	908.7	980.8	99.0	816.4	866.3	881.1	951.0
.2	840.2	891.5	906.8	978.7	.2	814.8	864.6	879.4	949.1
.4	838.4	889.7	904.9	976.7	.4	813.1	862.8	877.6	947.2
.6	836.7	887.8	903.0	974.7	.6	811.5	861.1	875.8	945.3
.8	835.0	886.0	901.2	972.7	.8	809.9	859.4	874.1	943.4
97.0	833.2	884.2	899.3	970.6	100.0	808.2	857.6	872.3	941.5
.2	831.5	882.4	897.4	968.7	.2	806.6	855.9	870.6	939.6
.4	829.8	880.5	895.6	966.7	.4	805.0	854.2	868.8	937.8
.6	828.1	878.7	893.8	964.7	.6	803.4	852.5	867.1	935.9
.8	826.4	876.9	891.9	962.7	.8	801.8	850.8	865.4	934.1
98.0	824.7	875.1	890.1	960.7	101.0	800.2	849.2	863.7	932.2
.2	823.1	873.4	888.3	958.8	.2	798.7	847.5	862.0	930.4
.4	821.4	871.6	886.5	956.8	.4	797.1	845.8	860.3	928.5
.6	819.7	869.8	884.7	954.9	.6	795.5	844.1	858.6	926.7
.8	818.1	868.1	882.9	953.0	.8	794.0	842.5	856.9	924.9
					102.0	792.4	840.8	855.2	923.1

## Alternating Current Heating Effects

If an alternating current be transmitted through a conductor, portions of the electrical energy supplied may be transformed into heat in four different ways, each resulting in an energy loss and in a corresponding reduction of the current carrying capacity of the conductor.

1. A definite amount of electrical energy will be required to overcome the ohmic resistance of the conductor, just as in the case with continuous currents. This is commonly known as the  $I^2R$  loss, where  $I$  is the effective current.

2. Under certain conditions there will be loss of energy due to the SKIN EFFECT of alternating currents. A current induced in a conductor builds up from the surface, and an appreciable period of time is required for the current to penetrate to the interior portions of the conductor. If the frequency be high the central portion of large conductors may contribute nothing to the conducting powers of the conductor. This is equivalent to increasing the resistance of the conductor, or in effect the conductor will have a spurious resistance which will be greater than its real resistance.

The effect is much greater in iron than in copper, owing to the high magnetic permeability of iron. It also increases directly with the frequency of alternations. With the two standard frequencies now being used, 25 and 60, the skin effect in copper does not become appreciable until a diameter of conductor of about three-quarters of an inch has been reached. In distribution systems which conduct heavy currents of high frequency, the conductor wires may be built up into cables about a hemp core, thus offering a greater amount of surface by placing the copper where it will do the greatest service without increasing its weight.

Approximate values of the effective resistance of straight copper conductors at 68 degrees F. can be obtained by multiplying the actual ohmic resistance by factors given in the following table:

### Factors to Obtain Effective Resistance from Ohmic Resistance

Diameter Bare Copper Conductor Inches	Approximate Area in Circular Mils	Frequency			Diameter Bare Copper Conductor Inches	Approximate Area in Circular Mils	Frequency		
		25	60	130			25	60	130
2.00	4,000,000	1.265	1.826	2.560	1.000	1,000,000	1.020	1.111	1.397
1.75	3,062,500	1.170	1.622	2.272	.75	563,500	1.007	1.040	1.156
1.50	2,500,000	1.098	1.420	1.983	.50	250,000	1.002	1.008	1.039
1.25	1,562,500	1.053	1.239	1.694	.46	211,600	1.001	1.006	1.027
1.125	1,265,625	1.035	1.168	1.545					

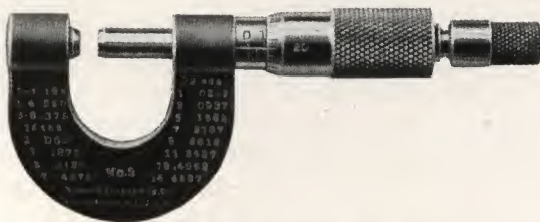
3. **FOUCOULT** or eddy currents may be induced in the conductor itself, or in the lead sheathing or in the steel armor wires by the rapidly changing alternating magnetic flux. Foucoults currents are produced at the expense of energy supplied the conductor, and they are dissipated in the form of heat. This loss would be much greater in single-conductor cables carrying alternating current than in two conductor or three-conductor cables, in which the outer resultant magnetic field should be very small. Placing a single-conductor alternating current cable in an iron conduit would very greatly increase the energy loss, and for that reason it is seldom done. This loss will be greater in solid conductors than in stranded conductors of equal section, and it will increase with thickness of lead sheath and with the diameter of the armor wires.

4. **DIELECTRIC HYSTERESIS** losses in the insulating material. This loss is somewhat similar in kind to the magnetic hysteresis loss in iron. A dielectric is a poorly conducting material used for insulating conductors, through which an electromotive force establishes a molecular strain or an electro-static field of flux. The total dielectric loss is due to the sum of a direct  $I^2 R$  leakage of current through the dielectric and to the dielectric hysteresis loss, which is thought to be a function of the insulation resistance, varying inversely. The hysteresis loss in the dielectric of a cable is constant and independent of load. It increases with voltage, with the length of cable and with frequency. It may be lessened by increasing the thickness of the dielectric, by using a dielectric of low specific inductive capacity and by working at low voltage and low frequency. The loss is thought to be negligible in direct current systems and in low voltage alternating current distribution systems.

While the amount of heat developed under ordinary service conditions by any one of the last three mentioned causes would probably be small, yet the aggregate amount tends to increase the temperature of the conductor, which increases its resistance, reduces its carrying capacity and shortens the life of the insulation.

## Measurements of Conductors

The diameter of a conductor is usually expressed in MILS. A mil is a thousandth part of an inch. The direct measurement of diameters in mils is made by wire gauges, of which there are several different types on the market. One type in common use is shown in the cut below.



Micrometer Calipers

The CIRCULAR MIL is very generally taken as the unit of area in considering the cross-section or capacity of electrical conductors. This is the area of a circle whose diameter is one mil, or one-thousandth of an inch. It equals .7854 of a square mil. This unit area possesses several advantages in making wiring calculations and in determining the relations between different wires having known diameters. The cross-section of any solid round wire in circular mils is found by squaring the diameter of the wire in mils, and conversely, the diameter of a wire in mils is obtained by extracting the square root of the section expressed in circular mils. The constant  $\pi$ , which expresses the ratio between the circumference and diameter of any circle, does not enter into these calculations, thus greatly simplifying them.

Circular mils = square inches  $\div$  .0000007854 = (diameter in mils)<sup>2</sup>

Square inches = circular mils  $\times$  .0000007854

One circular mil = .0005067087 square millimeters

One square millimeter = 1,973 circular mils

The **weight** in pounds per 1,000 feet of any conductor may be found by multiplying its area in circular mils by the "pounds per 1,000 feet per circular mil." tabulated on page 86.

## Wire Gauges

The sizes of wires are ordinarily expressed in certain gauge numbers arbitrarily chosen. There are unfortunately several independent gauge systems, and it is necessary in each case to specify the particular wire gauge used. Though the gauge numbers have the advantage of enabling manufacturers to carry wires in stock from which purchasers may choose with a reasonable assurance of quick delivery, there is nevertheless a tendency to do away with all gauge numbering methods and to distinguish different electrical wires by their diameters expressed in mils.

The American Wire Gauge (B. & S.) is used in America as the standard for copper wire used for electrical purposes. In this gauge both the sizes and the areas vary in geometrical progression. The diameters of wires are obtained from the geometric series, in which the first number, No. 4-0, = 0.46 inch in diameter, and No. 36 = .005 inch, the nearest fourth significant figure being retained in the areas and diameters

so obtained. It will be seen upon examining a wiring table that an increase of three in the wire number corresponds to doubling the resistance and halving the cross-section and weight. Also, that an increase of ten in the wire number increases the resistance ten times and diminishes the cross-section and weight to one-tenth their original values.

The American Steel and Wire Co.'s Steel Wire gauge is used almost universally in this country for steel and iron wires.

The Birmingham gauge is used largely in England as their standard, and in this country for steel wires, and for other wires not used especially for electrical purposes.

The table on page 70 gives the numbers and diameters in decimal parts of an inch for the various wire gauges used in this country and England.

### Wiring Formulae and Tables

The current carrying capacity of a conductor is not only limited by its allowable temperature rise, as already explained, but also by the allowable drop of potential. The potential difference required to transmit a given electric current through a conductor will vary directly as the resistance of the conductor and inversely as its cross-sectional area. The diameter of conductors used for long distance transmission purposes is usually determined by the drop of potential allowable, rather than from other electrical considerations.

For most practical purposes the following formulæ can be used to determine the size of copper conductors, current per wire, and weight of copper per circuit for any system of electrical distribution.

$$\text{Area of conductor in circular mils} = \frac{D \times W}{P \times E^2} K = C. M.$$

$$\text{Current in main conductor} = \frac{W}{E} T. \quad P = \frac{D \times W}{C. M. \times E^2} K$$

$$\text{Weight of copper} = \frac{D^2 \times W \times K \times A}{P \times E^2 \times 1,000,000}, \text{ pounds.}$$

In these equations the symbols used denote the following quantities:

W = total watts delivered.

D = distance of transmission, one way in feet.

E = voltage between main conductors at the receiving or consumers' end of circuit.

P = loss in line in per cent. of power delivered, i. e., of W, this being a whole number. K, T and A are constants given in the following table:

**Wiring Formulae Constants**

System	Values of A	Values of K					Values of T				
		Per Cent. Power Factor					Per Cent. Power Factor				
		100	95	90	85	80	100	95	90	85	80
1-phase, & D C	6.04	2160	2400	2660	3000	3380	1.00	1.05	1.11	1.17	1.25
2-phase-4 wire.	12.08	1080	1200	1330	1500	1690	.50	.53	.55	.59	.66
3-phase-3 wire.	9.06	1080	1200	1330	1500	1690	.58	.61	.64	.68	.72

These constants depend upon the system of distribution as well as the conditions of the circuit.

For continuous current  $K=2160$ ,  $T=1$  and  $A=6.04$ .

For any particular power factor the value of  $K$  is obtained by dividing 2160, the value for continuous current, by the square of the power factor for single-phase and by twice the square of the power factor for three-wire three-phase or four-wire two-phase. In continuous current Edison three-wire systems, the neutral should be made of one-third the section obtained by the formula for either of the outside mains. In both continuous and alternating current systems, the neutral conductor, for secondary mains (i. e., service connections) and house wiring, should be taken as large as the other conductor. The three wires of a three-phase circuit and the four wires of a two-phase circuit should all be of the same size, and each conductor should be of the cross-section, as obtained by the proper application of the first formula.

The following assumed values of power factors for circuits may be used in any calculation when their exact values are not known.

Incandescent lighting and synchronous motors, 95 per cent.

Lighting and induction motors, 85 per cent.

Induction motors alone, 80 per cent.

For continuous currents and for short branch circuits in wiring buildings, for lamp and motor outlets, the following formula for determining area of conductor is found more convenient to use.

$$\text{Circular mils} = \frac{10.8 \times \text{Amperes} \times \text{Length of circuit in feet.}}{\text{Volts permissible drop in wire.}}$$

For example: What size of wire would be required for an 800-foot circuit carrying current to a 500-volt, 20-kilowatt, direct current motor, allowing 2 per cent. drop in the circuit.

20 kilowatts = 20,000 watts.

$20,000 \div 500 = 40$  amperes in line.

1 per cent. loss in each wire or branch of circuit =  $500 \times .01 = 5$  volts.

Length of each wire = 800 feet.

$$\text{Circular mils} = \frac{10.8 \times 40 \times 800}{5} = 69,120 \text{ or No. 2 B. \& S. wire say}$$

for each branch of the circuit.

A bare **cable** may be defined as consisting of any group of wires twisted together helically, or it may be composed of any number of such groups. The term **wire** indicates the individual solid wires in a cable.

A **strand** is a group of single wires in one or more layers, twisted together helically and symmetrically with a uniform pitch around a single central wire or neutral axis. This construction is sometimes called **concentric strand**.

The term **bunched strand** is sometimes applied to a collection of straight or twisted wires which are grouped together with little regard to their geometrical arrangements.

The cut on page 97 represents the manner in which a concentric strand with 7 layers is built up. The first layer consists of six wires twisted spirally around the central wire or core. The second layer has 12 wires or  $6 + 6$ , the third 18 wires or  $12 + 6$ , and so on, each succeeding layer having 6 more wires than the one underneath. The total number of wires in this type of strand would be,

$$\begin{array}{rcl} \text{For 1 layer,} & 1 + 6 & = 7 \\ \text{2 layers,} & 7 + 12 & = 19 \\ \text{3 layers,} & 19 + 18 & = 37 \\ \text{4 layers,} & 37 + 24 & = 61 \end{array}$$

---


$$\text{7 layers, } 127 + 42 = 169$$

This can be expressed by the following formula, where  $n$  is the number of layers over the core:

$$\text{Total number of wires} = 3n(1 + n) + 1.$$

In this type of strand, all wires are of the same size and each successive layer of wires after the second is twisted in a reverse direction from the preceding one, making the external diameter symmetrical and cylindrical. It is the most compact form, it has the smallest diameter for a given capacity and presents the smoothest and most uniform external surface possible to obtain. These are very necessary qualifications for the production of a high grade insulated cable. The insulation, whether it be rubber, paper, cambric or other material, will have a more uniform thickness on a concentric strand than on any other, due to the evenness of its external diameter.

As the successive layers are wound in opposite directions, the wires will not fit into the grooves between the wires underneath. The diameter of such a strand will therefore equal the sum of the diameters of the individual wires crossing each other in any diameter. It will equal  $d(2n + 1)$ , where  $d$  is the diameter of each wire and  $n$  the number of layers.

The axial length of one complete turn of a wire in a strand is called the **pitch**, or the **lay** of the strand. This is often expressed in terms of the diameter of the strand. There is no one fixed standard pitch used by all cable makers. An extended experience in cable making has shown us that the particular system of laying wires in a strand outlined in the following tables gives best results. This is based on placing the wires in the strand at a uniform angle with the core. The "per cent. take-up of whole strand" represents also the per cent. increase in weight of a strand over a solid wire of equal cross-section.

If a longer twist were used than that given in the table on page 81, the wires in the strand would not bind together properly, and if a shorter twist be employed, the per cent. of take-up of the wires and the weight would be increased.

The best copper strands are made on machinery which permits the wires to be laid into the strand without torsion. Where torsion is present, it has a bad effect on the strand and on the physical characteristics of the wire.

The sectional area of a cable in circular mils is obtained by multiplying the area of each wire in circular mils measured at right angles to its axis, by the number of wires. Copper strands larger in sectional area than 4/0 B. & S. gauge are usually classified according to their total area in circular mils; smaller copper cables are nearly always classified in the B. & S. gauge. The area in circular mils ( $d^2$ ) of any one wire equals the circular mils of the cable divided by the number of wires in the cable. The diameter of any wire in mils will equal, as explained elsewhere, the square root  $\sqrt{d^2}$  of the area of the wire expressed in circular mils. The individual wires of a cable can seldom be drawn to any of the standard gauge numbers, because the diameter of the wire is fixed by the required size of the cable, and the number of wires composing it.

## Electrical Units

**OHM (R)**—The unit of resistance. The international standard ohm is represented by the resistance offered to an unvarying electric current by a column of mercury 106.3 centimeters long and 14.4521 grams mass at 0°C.

**MEGOHM**—One million (1,000,000) ohms.

**AMPERE (I)**—The unit of current. The international standard ampere is practically represented by the unvarying current which when passed through a solution of nitrate of silver in water, deposits silver at the rate of .001118 grams per second.

**VOLT (E)**—The unit of electro-motive force. It is the E.M.F. which applied to one ohm, will produce a current of one ampere.

**COULOMB (Q)**—The unit of quantity. It is the quantity of electricity transferred by a current of one ampere in one second.

**FARAD (C)**—The unit of capacity. It is the capacity of a conductor charged to a potential of one volt by one coulomb.

**JOULE**—The unit of work. It is the energy expended in one second by one ampere in one ohm.

**WATT**—Unit of power. It is one ampere at E.M.F. of one volt and equals one joule per second.

**HENRY (L)**—Unit of induction. It is the induction in a circuit when the E.M.F. induced is one volt while the inducing current varies one ampere per second.

**FREQUENCY (f)**—The frequency of an alternating current circuit is the number of cycles through which it passes per second.

**REACTANCE (X)**—An apparent resistance of an alternating current circuit due to induction and capacity. It is expressed as  $X = 2\pi fL - \frac{1}{2\pi fC}$

**IMPEDANCE (Z)**—The apparent resistance of an alternating current circuit,

$$Z = \sqrt{R^2 + X^2} \quad \text{or} \quad \sqrt{R^2 + (2\pi fL - \frac{1}{2\pi fC})^2}$$

**POWER FACTOR ( $\cos \theta$ )**. — The ratio of the power to the apparent power

**DIRECT CURRENT CIRCUITS.**

$$I = \frac{E}{R}, \quad E = IR, \quad P = EI \qquad P = \text{watts loss} = I^2R$$

**ALTERNATING CURRENT CIRCUITS**

$$I = \frac{E}{Z}, \quad E = IZ \qquad P = \text{watts loss} = I^2R$$

$$\text{SINGLE PHASE,} \quad P = EI \cos \theta \qquad I = \frac{P}{E \cos \theta}$$

$$\text{TWO PHASE,} \quad P = 2EI \cos \theta \qquad I = \frac{P}{2E \cos \theta}$$

$$\text{THREE PHASE,} \quad P = 3EI \cos \theta \qquad I = \frac{P}{3E \cos \theta}$$

## Weights and Measures

### Metric and English Equivalents

#### Linear

1 millimeter (MM)	=	.03937 inch	=	39.37 Mils.
1 centimeter (CM)	=	.3937 inch	=	.032808 foot
1 meter (M)	=	39.37 inches	=	3.2808 feet = 1.0936 yards
1 kilometer (KM)	=	3281 feet	=	1093.6 yards = .62137 mile
1 inch	=	25.40 millimeters	=	2.54 centimeters
1 foot	=	30.48 centimeters	=	.3048 meter
1 yard	=	91.44 centimeters	=	.9144 meter
1 mile	=	1609.35 meters	=	1.609 kilometers

#### Surface

1 square millimeter	=	.00155 square inch	=	1973 circular mils
1 square centimeter	=	.155 square inch	=	197351 circular mils
1 square meter	=	1550 square inches	=	10.7639 square feet = 1.196 sq.yd.
1 circular mil	=	.0005067 square millimeter		
1 square inch	=	645.16 square millimeters	=	6.4516 square centimeters
1 square foot	=	929.03 square centimeters	=	.0929 square meter
1 square yard	=	.8361 square meter		

#### Weight

1 gram	=	15.432 grain	=	.03527 ounce
1 kilogram	=	15432 grains	=	35.27 ounces = 2.2046 pounds
1 metric ton	{ = 1000 kilograms	=	2204.6 pounds	
	{ = .9842 gross ton	=	1.1023 net tons	
1 grain	=	.0648 gram		
1 ounce	=	28.352 grams		
1 pound	=	453.6 grams	=	.4536 kilogram
1 net ton	=	907.2 kilograms	=	.9072 metric ton
1 gross ton	=	1016 kilograms	=	1.016 metric tons

#### Volume

1 cubic centimeter	=	.06102 cubic inch		
1 cubic meter	=	35.314 cubic feet	=	1.308 cubic yard
1 liter	=	61.02 cubic inches	=	.0353 cubic foot
1 cubic inch	=	16.387 cubic centimeters		
1 cubic foot	=	28.316 liters	=	.03832 cubic meter
1 cubic yard	=	.765 cubic meter		

## Weights and Measures—Continued

### Metric and English Equivalents

#### Liquid Measure

1 liter	=	33.8	fluid ounces	=	.908	quart	=	.2642	gallon
1 fluid ounce	=	.0295	liter						
1 quart	=	1.1013	liters						
1 gallon	=	231	cubic inches	=	3.785	liters			

---

#### Mass—Length

1 kilogram per kilometer	1 pound per 1000 ft.
= 1 gram per meter	= 5.28 pounds per mile
= .672 pounds per 1000 feet	= 1.4882 kilograms per kilometer
= 3.55 pounds per mile	= 1.4882 grams per meter

#### Weight—Area

1 kilogram per square meter	1 pound per square inch
= .1 grams per square centimeter	= 703 kilograms per square meter
= .001422 pounds per square inch	= 144 pounds per square foot
= .2048 pounds per square foot	= 2.307 feet of water
= .00328 feet of water	= .703 meters of water
= .001 meters of water	= 2.036 inches of mercury
= .00290 inches of mercury	= 51.7 millimeters of mercury
= .0736 millimeters of mercury	= .0680 atmospheres
= .0000968 atmospheres	

#### Mass—Volume

1 gram per cubic centimeter		1 pound per cubic inch	
= 1	kilogram per liter	= 27.68	grams per cubic centimeter
= .0361	pounds per cubic inch	= .62768	kilograms per cubic centimeter
= 62.4	pounds per cubic foot		
= 1	metric ton per cubic meter.		

## Weights and Measures—Continued

### Metric and English Equivalents

#### Speed

1 foot per second  
 = .682 miles per hour  
 = .592 knots per hour  
 = .305 meters per second  
 = 1.097 kilometers per hour

1 centimeter per second  
 = .036 kilometers per hour  
 = 1.969 feet per minute  
 = .0328 feet per second  
 = .02237 miles per hour

1 mile per hour  
 = 88 feet per minute  
 = 1.467 feet per second  
 = .01667 miles per minute  
 = .8684 knots per hour  
 = 1.609 kilometers per hour  
 = 26.82 meters per minute  
 = .447 meters per second

1 kilometer per hour  
 = .2778 meters per second  
 = .911 feet per second  
 = .621 miles per hour  
 = .540 knots per hour

---

#### Acceleration

1 foot per second per second  
 = 30.5 centimeters per second per second

1 centimeter per second per second  
 = .0328 feet per second per second

---

#### Acceleration Due to Gravity

45° Lat.

Sea Level

Acceleration  
 = 32.17 feet per second per second

Acceleration  
 = 980.6 centimeters per second per second

---

#### Force

1 pound = 32.2 poundals  
 = 444980. dynes  
 1 poundal = .0311 pounds  
 = 13840. dynes  
 = .01410 kilograms

1 gram = 981. dynes  
 = .0709 poundals  
 1 dyne = .00102 grams  
 = .0000723 poundals  
 = .000002249 pounds

## Weights and Measures—Continued

### Metric and English Equivalents

#### Work—Heat

1 foot pound  
= 13,560,000 ergs  
= .1383 kilogram-meters  
= .001285 B. T. U.  
= .324 calories

1 kilogram-meter  
= 98,100,000 ergs  
= 7.23 foot-pounds  
= .00930 B. T. U.  
= 2.342 calories

---

1 British Thermal Unit (B. T. U.)  
= 1055 joules  
= 778 foot-pounds  
= 252 calories  
= 107.6 kilogram-meters

1 joule = .00948 B. T. U.  
= 10,000,000 ergs  
= .738 foot-pounds  
= .2389 calories  
= .102 kilogram-meters

---

#### Power

1 Horsepower  
= 550 foot-pounds per second  
= 76 kilogram-meters per second  
= 746 watts

1 metric Horsepower  
= 542 foot-pounds per second  
= 75 kilogram-meters per second  
= 736 watts

---

1 watt = 1 joule per second  
= .738 foot-pounds per second  
= .00134 Horsepower  
= .001359 metric Horsepower

## Physical Data

One cubic foot of water weighs 62.355 pounds at 62° fahr.

One cubic foot of air weighs 0.0807 pounds at 32° fahr. and one atmosphere.

One cubic foot of hydrogen weighs 0.00557 pounds.

One foot-pound =  $1.3562 \times 10^7$  ergs.

One horse power hour =  $33,000 \times 60$  foot-pounds.

One atmosphere = 14.7 pounds per square inch.

= 2116 pounds per square foot.

= 760 mm. of mercury.

Velocity of sound at 0° cent. in dry air = 332.4 metres per second.

= 1091 feet per second.

Velocity of light in vacuum = 299,853 km. per second.

= 186,325 miles per second.

Specific heat of air at constant pressure = 0.237.

A column of water 2.3 feet high corresponds to a pressure of 1 pound per square inch.

Coefficient of expansion of gases =  $\frac{1}{273}$  = 0.00367.

Latent heat of water = 79.24.

Latent heat of steam = 535.9.

**CENTIGRADE DEGREES.** To convert into the corresponding one in Fahrenheit degrees, multiply by  $\frac{9}{5}$  and add 32. To convert it into the one in Réaumur degrees multiply by  $\frac{4}{5}$ . To convert it into the one on the Absolute scale, add 273.

**FAHRENHEIT DEGREES.** To convert into the one in centigrade degrees, subtract 32 and then multiply by  $\frac{5}{9}$ , being careful about the signs when the reading is below the melting point of ice. To convert it into the one in Réaumur degrees, subtract 32 and multiply by  $\frac{4}{9}$ . To convert it into the one on the Absolute scale, subtract 32, then multiply by  $\frac{5}{9}$  and add 273; or multiply by 5, add 2297, and divide by 9.

## Physical Properties of Metals

METALS	Weight per Cubic Inch in Pounds	Ultimate Tensile Strength. Pounds per sq. Inch	Melting Point in Cent. Degrees	Specific Heat	Coefficient of Linear Expansion Below 100° Cent.	Ohms Res. per Mil ft. 20° Cent.	Tempt. Coefficient. K. Cent. Degrees
Antimony.....	0.243	.....	440	0.0508	0.00001129	230.2	0.00389
Aluminum, annealed.....	.096	15,000	625	.2185	.00002310	18.21	.00390
Bismuth.....	.354	6,400	266	.0298	.00001755	845.20	.00354
Brass, Cast.....	.303	18,000	1020	.0939	.00001720	45.00	.....
Copper, Annealed.....	.319	30,000	1054	.0951	.00001596	10.35	.00388
Copper, Hard Drawn.....	.322	60,000	1200	.0951	.....	10.7	.00388
German Silver Wire.....	.307	87,000	1093	.....	.....	126.6	.000443
Gold, Annealed.....	.695	.....	1046	.0324	.00001415	13.28	.00365
Iron, Cast.....	.260	16,500	1220	.1298	.00001001	380.	.00453
Iron, Wrought.....	.278	52,000	1620	.1138	.000011660	63.21	.0054
Lead.....	.411	3,300	325	.0314	.00002828	126.10	.00387
Manganese Steel.....	.282	.....	1260	.....	.....	245.	.00122
Mercury.....	.49	.....	-39.4	.0333	.00006	577.6	.0007485
Nickel.....	.318	.....	1620	.1150	.00001251	74.73	.0041
Platinum.....	.765	.....	1800	.0324	.00000863	56.69	.0039
Phosphor Bronze.....	.321	64,700	.....	.....	.....	39.6	.....
Silicon Bronze.....	.321	75,000	.....	.....	.....	12.9	.....
Silver.....	.379	.....	950	.0570	.00001943	10.48	.00377
Steel, High Carbon.....	.283	100,000	1410	.1175	.00001240	118.	.0050
Solder, Tin 1, Lead 1.....	.338	7,500	187	.....	.....	111.	.....
Tin.....	.265	4,500	230	.0562	.00002094	84.57	.00365
Zinc.....	.255	7,500	416	.0956	.00002532	36.60	.00365

## Conversion of Mils to Millimeters

Mils	Milli- meters	Mils	Milli- meters	Mils	Milli- meters	Mils	Milli- meters	Mils	Milli- meters
1	.0254	21	.5334	41	1.0414	61	1.5494	81	2.0574
2	.0508	22	.5588	42	1.0668	62	1.5748	82	2.0828
3	.0762	23	.5842	43	1.0922	63	1.6002	83	2.1082
4	.1016	24	.6096	44	1.1176	64	1.6256	84	2.1336
5	.1270	25	.6350	45	1.1430	65	1.6510	85	2.1590
6	.1524	26	.6604	46	1.1684	66	1.6764	86	2.1844
7	.1778	27	.6858	47	1.1938	67	1.7018	87	2.2098
8	.2032	28	.7112	48	1.2192	68	1.7272	88	2.2352
9	.2286	29	.7366	49	1.2446	69	1.7526	89	2.2606
10	.2540	30	.7620	50	1.2700	70	1.7780	90	2.2860
11	.2794	31	.7874	51	1.2954	71	1.8034	91	2.3114
12	.3048	32	.8128	52	1.3208	72	1.8288	92	2.3368
13	.3302	33	.8382	53	1.3462	73	1.8542	93	2.3622
14	.3556	34	.8636	54	1.3716	74	1.8796	94	2.3876
15	.3810	35	.8890	55	1.3970	75	1.9050	95	2.4130
16	.4064	36	.9144	56	1.4224	76	1.9304	96	2.4384
17	.4318	37	.9398	57	1.4478	77	1.9558	97	2.4638
18	.4572	38	.9652	58	1.4732	78	1.9812	98	2.4892
19	.4826	39	.9906	59	1.4986	79	2.0066	99	2.5146
20	.5080	40	1.0160	60	1.5240	80	2.0320	100	2.5400

## Conversion of Millimeters to Mils

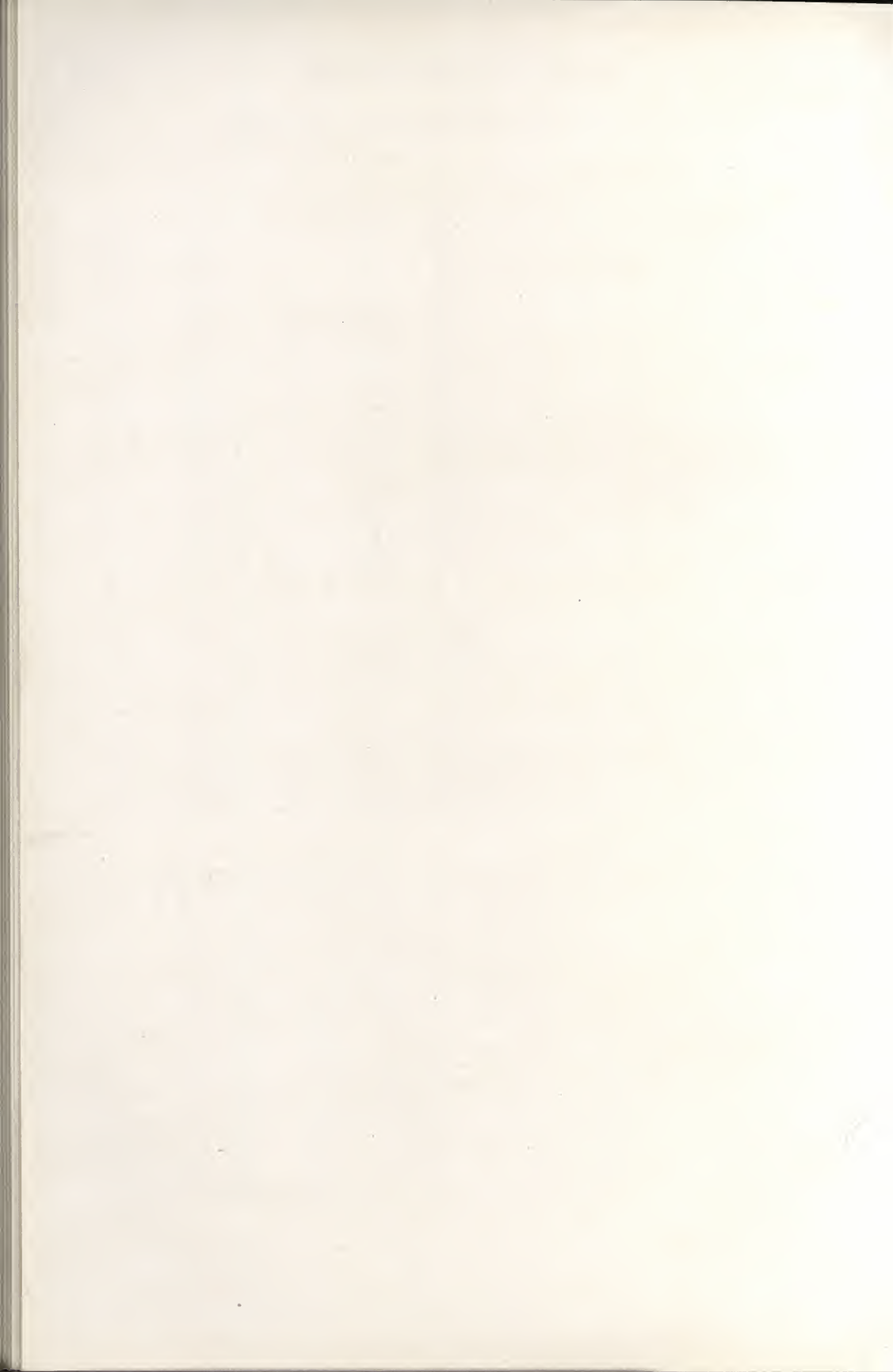
Milli- meters	Mils	Milli- meters	Mils	Milli- meters	Mils	Milli- meters	Mils	Milli- meters	Mils
1	39.370	21	826.77	41	1614.17	61	2401.57	81	3188.97
2	78.740	22	866.14	42	1653.54	62	2440.94	82	3228.34
3	118.110	23	905.51	43	1692.91	63	2480.31	83	3267.71
4	157.48	24	944.88	44	1732.28	64	2519.68	84	3307.08
5	196.85	25	984.25	45	1771.65	65	2559.05	85	3346.45
6	236.22	26	1023.60	46	1811.02	66	2598.42	86	3385.82
7	275.59	27	1063.00	47	1850.39	67	2637.79	87	3425.19
8	314.96	28	1102.40	48	1889.76	68	2677.16	88	3464.56
9	354.33	29	1141.70	49	1929.13	69	2716.53	89	3503.93
10	393.70	30	1181.10	50	1968.50	70	2755.90	90	3543.30
11	433.07	31	1220.50	51	2007.87	71	2795.27	91	3582.67
12	472.44	32	1259.80	52	2047.24	72	2834.64	92	3622.04
13	511.81	33	1299.20	53	2086.61	73	2874.01	93	3661.41
14	551.18	34	1338.60	54	2125.98	74	2913.38	94	3700.78
15	590.55	35	1378.00	55	2165.35	75	2952.75	95	3740.15
16	629.92	36	1417.30	56	2204.72	76	2992.12	96	3779.52
17	669.29	37	1456.70	57	2244.09	77	3031.49	97	3818.89
18	708.66	38	1496.10	58	2283.46	78	3070.86	98	3858.26
19	748.03	39	1535.40	59	2322.83	79	3110.23	99	3897.63
20	787.40	40	1574.80	60	2362.20	80	3149.60	100	3937.00

Areas and Circumferences of Circles

Diam-eter	Circum-ference	Area	Diam-eter	Circum-ference	Area	Diam-eter	Circum-ference	Area
$\frac{1}{16}$	.049087	.00019	1. $\frac{11}{16}$	6.08684	2.9483	4. $\frac{11}{16}$	15.5116	19.147
$\frac{1}{8}$	.098175	.00077	2. $\frac{1}{8}$	6.28319	3.1416	5. $\frac{1}{8}$	15.7080	19.635
$\frac{3}{16}$	.147262	.00173	$\frac{1}{4}$	6.47953	3.3410	$\frac{1}{4}$	15.9043	20.129
$\frac{1}{4}$	.196350	.00307	$\frac{3}{8}$	6.67588	3.5466	$\frac{3}{8}$	16.1007	20.629
$\frac{5}{16}$	.294524	.00690	$\frac{1}{2}$	6.87223	3.7583	$\frac{1}{2}$	16.2970	21.135
$\frac{3}{8}$	.392699	.01227	$\frac{3}{4}$	7.06858	3.9761	$\frac{3}{4}$	16.4934	21.648
$\frac{1}{2}$	.490874	.01917	$\frac{7}{8}$	7.26493	4.2000	$\frac{7}{8}$	16.6897	22.166
$\frac{5}{8}$	.589049	.02761	$\frac{15}{16}$	7.46128	4.4301	$\frac{15}{16}$	16.8861	22.691
$\frac{3}{4}$	.687223	.03758	$\frac{1}{8}$	7.65763	4.6664	$\frac{1}{8}$	17.0824	23.221
$\frac{7}{8}$	.785398	.04909	$\frac{1}{16}$	7.85398	4.9087	$\frac{1}{16}$	17.2788	23.758
$\frac{15}{16}$	.883573	.06213	$\frac{1}{32}$	8.05033	5.1572	$\frac{1}{32}$	17.4751	24.301
$\frac{31}{32}$	.981748	.07670	$\frac{1}{64}$	8.24668	5.4119	$\frac{1}{64}$	17.6715	24.850
1	1.07992	.09281	$\frac{1}{128}$	8.44303	5.6727	$\frac{1}{128}$	17.8678	25.406
$\frac{1}{8}$	1.17810	.11045	$\frac{1}{256}$	8.63938	5.9396	$\frac{1}{256}$	18.0642	25.967
$\frac{1}{16}$	1.27627	.12962	$\frac{1}{512}$	8.83573	6.2126	$\frac{1}{512}$	18.2605	26.535
$\frac{1}{32}$	1.37445	.15033	$\frac{1}{1024}$	9.03208	6.4918	$\frac{1}{1024}$	18.4569	27.109
$\frac{1}{64}$	1.47262	.17257	$\frac{1}{2048}$	9.22843	6.7771	$\frac{1}{2048}$	18.6532	27.688
$\frac{1}{128}$	1.57080	.19635	$\frac{1}{4096}$	9.42478	7.0686	6. $\frac{1}{8}$	18.8496	28.274
$\frac{1}{256}$	1.66897	.22166	$\frac{1}{8192}$	9.62113	7.3662	$\frac{1}{8192}$	19.2423	29.465
$\frac{1}{512}$	1.76715	.24850	$\frac{1}{16384}$	9.81748	7.6699	$\frac{1}{16384}$	19.6350	30.680
$\frac{1}{1024}$	1.86532	.27688	$\frac{1}{32768}$	10.0138	7.9798	$\frac{1}{32768}$	20.0277	31.919
$\frac{1}{2048}$	1.96350	.30680	$\frac{1}{65536}$	10.2102	8.2958	$\frac{1}{65536}$	20.4204	33.183
$\frac{1}{4096}$	2.06167	.33824	$\frac{1}{131072}$	10.4065	8.6179	$\frac{1}{131072}$	20.8131	34.472
$\frac{1}{8192}$	2.15984	.37122	$\frac{1}{262144}$	10.6029	8.9462	$\frac{1}{262144}$	21.2058	35.785
$\frac{1}{16384}$	2.25802	.40574	$\frac{1}{524288}$	10.7992	9.2806	$\frac{1}{524288}$	21.5984	37.122
$\frac{1}{32768}$	2.35619	.44179	$\frac{1}{1048576}$	10.9956	9.6211	7. $\frac{1}{8}$	21.9911	38.485
$\frac{1}{65536}$	2.45437	.47937	$\frac{1}{2097152}$	11.1919	9.9678	$\frac{1}{2097152}$	22.3838	39.871
$\frac{1}{131072}$	2.55254	.51849	$\frac{1}{4194304}$	11.3883	10.321	$\frac{1}{4194304}$	22.7765	41.282
$\frac{1}{262144}$	2.65072	.55914	$\frac{1}{8388608}$	11.5846	10.680	$\frac{1}{8388608}$	23.1692	42.718
$\frac{1}{524288}$	2.74889	.60132	$\frac{1}{16777216}$	11.7810	11.045	$\frac{1}{16777216}$	23.5619	44.179
$\frac{1}{1048576}$	2.84707	.64504	$\frac{1}{33554432}$	11.9773	11.416	$\frac{1}{33554432}$	23.9546	45.664
$\frac{1}{2097152}$	2.94524	.69029	$\frac{1}{67108864}$	12.1737	11.793	$\frac{1}{67108864}$	24.3473	47.173
$\frac{1}{4194304}$	3.04342	.73708	$\frac{1}{134217728}$	12.3700	12.177	$\frac{1}{134217728}$	24.7400	48.707
$\frac{1}{8388608}$	3.14159	.78540	$\frac{1}{268435456}$	12.5664	12.566	8. $\frac{1}{8}$	25.1327	50.265
$\frac{1}{16777216}$	3.23974	.83464	$\frac{1}{536870912}$	12.7627	12.962	$\frac{1}{536870912}$	25.5254	51.849
$\frac{1}{33554432}$	3.33794	.88402	$\frac{1}{1073741824}$	12.9591	13.364	$\frac{1}{1073741824}$	25.9181	53.456
$\frac{1}{67108864}$	3.43609	.93449	$\frac{1}{2147483648}$	13.1554	13.772	$\frac{1}{2147483648}$	26.3108	55.088
$\frac{1}{134217728}$	3.53429	.98504	$\frac{1}{4294967296}$	13.3518	14.186	$\frac{1}{4294967296}$	26.7035	56.745
$\frac{1}{268435456}$	3.63244	1.0356	$\frac{1}{8589934592}$	13.5481	14.607	$\frac{1}{8589934592}$	27.0962	58.426
$\frac{1}{536870912}$	3.73064	1.0862	$\frac{1}{17179869184}$	13.7445	15.033	$\frac{1}{17179869184}$	27.4889	60.132
$\frac{1}{1073741824}$	3.82879	1.1368	$\frac{1}{34359738368}$	13.9408	15.466	$\frac{1}{34359738368}$	27.8816	61.862
$\frac{1}{2147483648}$	3.92699	1.1874	$\frac{1}{68719476736}$	14.1372	15.904	9. $\frac{1}{8}$	28.2743	63.617
$\frac{1}{4294967296}$	4.02514	1.2379	$\frac{1}{137438953472}$	14.3335	16.349	$\frac{1}{137438953472}$	28.6670	65.397
$\frac{1}{8589934592}$	4.12334	1.2884	$\frac{1}{274877906944}$	14.5299	16.800	$\frac{1}{274877906944}$	29.0597	67.201
$\frac{1}{17179869184}$	4.22149	1.3389	$\frac{1}{549755813888}$	14.7262	17.257	$\frac{1}{549755813888}$	29.4524	69.029
$\frac{1}{34359738368}$	4.31969	1.3894	$\frac{1}{1099511627776}$	14.9226	17.721	$\frac{1}{1099511627776}$	29.8451	70.882
$\frac{1}{68719476736}$	4.41784	1.4399	$\frac{1}{2199023255552}$	15.1189	18.190	$\frac{1}{2199023255552}$	30.2378	72.760
$\frac{1}{137438953472}$	4.51599	1.4904	$\frac{1}{4398046511104}$	15.3153	18.665	$\frac{1}{4398046511104}$	30.6305	74.662

Decimals of an Inch and Millimeters for Each 1-64 Inch

$\frac{1}{16}$ In.	$\frac{1}{8}$ In.	Decimal Inch	Decimal mm.	Fraction	$\frac{1}{16}$ In.	$\frac{1}{8}$ In.	Decimal Inch	Decimal mm.	Fraction	$\frac{1}{16}$ In.	$\frac{1}{8}$ In.	Decimal Inch	Decimal mm.	Fraction	$\frac{1}{16}$ In.	$\frac{1}{8}$ In.	Decimal Inch	Decimal mm.	Fraction
1	2	.015625	.3968		9	17	.265625	6.7467		17	33	.515625	13.0966		25	49	.765625	19.4465	
2	3	.03125	.7937		18	34	.28125	7.1436		34	67	.53125	13.4934		50	78	.78125	19.8433	
3	4	.046875	1.1906		19	35	.296875	7.5404		35	69	.546875	13.8903		51	79	.796875	20.2402	
4	5	.0625	1.5874		20	36	.3125	7.9373		36	71	.5625	14.2872		52	80	.8125	20.6371	$\frac{1}{8}$
5	6	.078125	1.9843		21	37	.328125	8.3342		37	72	.578125	14.6841		53	81	.828125	21.0339	
6	7	.09375	2.3812		22	38	.34375	8.7310		38	73	.59375	15.0809		54	82	.84375	21.4308	
7	8	.109375	2.7780		23	39	.359375	9.1279		39	74	.609375	15.4778		55	83	.859375	21.8277	
8	9	.125	3.1749	$\frac{1}{8}$	24	40	.375	9.5248	$\frac{1}{2}$	40	80	.625	15.8747	$\frac{1}{2}$	56	84	.875	22.2245	$\frac{1}{2}$
9	10	.140625	3.5718		25	41	.390625	9.9216		41	81	.640625	16.2715		57	85	.890625	22.6214	
10	11	.15625	3.9686		26	42	.40625	10.3185		42	82	.65625	16.6684		58	86	.90625	23.0183	
11	12	.171875	4.3655		27	43	.421875	10.7154		43	83	.671875	17.0653		59	87	.921875	23.4151	
12	13	.1875	4.7624	$\frac{1}{4}$	28	44	.4375	11.1122		44	84	.6875	17.4621	$\frac{1}{4}$	60	88	.9375	23.8120	$\frac{1}{4}$
13	14	.203125	5.1592		29	45	.453125	11.5091		45	85	.703125	17.8590		61	89	.953125	24.2089	
14	15	.21875	5.5561		30	46	.46875	11.9060		46	86	.71875	18.2559		62	90	.96875	24.6057	
15	16	.234375	5.9530		31	47	.484375	12.3029		47	87	.734375	18.6527		63	91	.984375	25.0026	
16	17	.25	6.3498	$\frac{1}{4}$	32	48	.5	12.6997	$\frac{1}{2}$	48	88	.75	19.0496	$\frac{3}{4}$	64	92	1	25.3995	1



# **Systems of Wiring**

## Modern House Wiring

### Providing for Complete Electric Service in the Home— Safety and Convenience Require Dependable Wiring System with Ample Outlets and Switches

The houses in which the country's population resides constitute the largest class of buildings. They range from the almost barren one-room shelter of the poorest laborer to the palatial residence of the multi-millionaire. Their construction and equipment is of the keenest interest to practically all the inhabitants because of the large amount of time spent in the home. At present only a fraction of American homes, probably not over one-fourth, are wired for electric service. The desire for making the home more comfortable and attractive is universal, however. For these various reasons the subject of house wiring should be of great interest to the house owner, the architect and builder, as well as to the various branches of the electrical industry. To the latter it presents special opportunities because of the very large number of buildings involved.

Ideas as to what constitutes proper provision for electric service in the home have been rapidly advanced with the progress of electrical science. When electric service was introduced into the home barely 30 years ago, electric light with only one or two lamps per room was all that was thought of. The wiring was put largely into wooden moldings. Sockets and fixtures were crude. Within the last twenty years other electrical devices have gradually been introduced into the household—the electric flatiron, fan motor, vacuum cleaner, washing machine, cooking and heating appliances, etc.—while at the same time electric lighting equipment (lamps, fixtures, portables and accessories) has been made more varied, useful and attractive, and is therefore much more extensively used. House wiring practice has also advanced greatly, but of this less is known by the general public.

For this reason architects and builders seldom make fully adequate provision for electric service. One still hears such expressions as, "Have your house wired for electric light," it being implied that this will be almost the only use to be made of electricity. Most houses are still being wired on this idea, in fact, even the layout of the lighting and selection of fixtures is usually left as almost the last detail of the plans. The specifications also are commonly incomplete and vague, and show that they were drawn up by one who had little knowledge of what a wiring system should provide and how it should be put in.

One of the commonest errors is to arrange for too few wall outlets and switches, which prevents getting fully satisfactory or pleasing lighting effects and hampers the use of the many portable electrical appliances, unless these are connected to lighting fixtures. This is not good practice, first, because it is usually very inconvenient, second, it spoils the appearance of the fixture to have cords dangling from it, and third,

it is unsafe because it frequently imposes a heavier current on the fixture wire and sockets than these are designed for. Key and pull chain sockets get out of order under such usage for which they are not intended and electric service suffers in reputation.

The solution is to provide plenty of receptacles of the wall, baseboard or floor types for the convenient connection of portable lamps and other appliances, whose use is bound to increase steadily. Provision should also be made so that complete electric cooking can be done later. An electric range requires a heavy, special circuit; the conduit to permit these large wires to be drawn in later can be installed at much less expense when the house is built than after it is occupied. All these extra outlets and switches with their additional wiring add to the cost of the wiring, of course, but this added cost is much smaller than when the outlets are put in later. If the latter is never done, inconvenience and sometimes danger results and the full benefits of electric service in the home cannot be realized. The householder cannot afford to sacrifice safety and convenience in his home on account of a slight increase in its cost. He should realize that a good wiring installation will require little if any change, and that it is a permanent investment which adds not only to the comfort and safety of his family, but also to the value of his residence if he should ever wish to sell it.

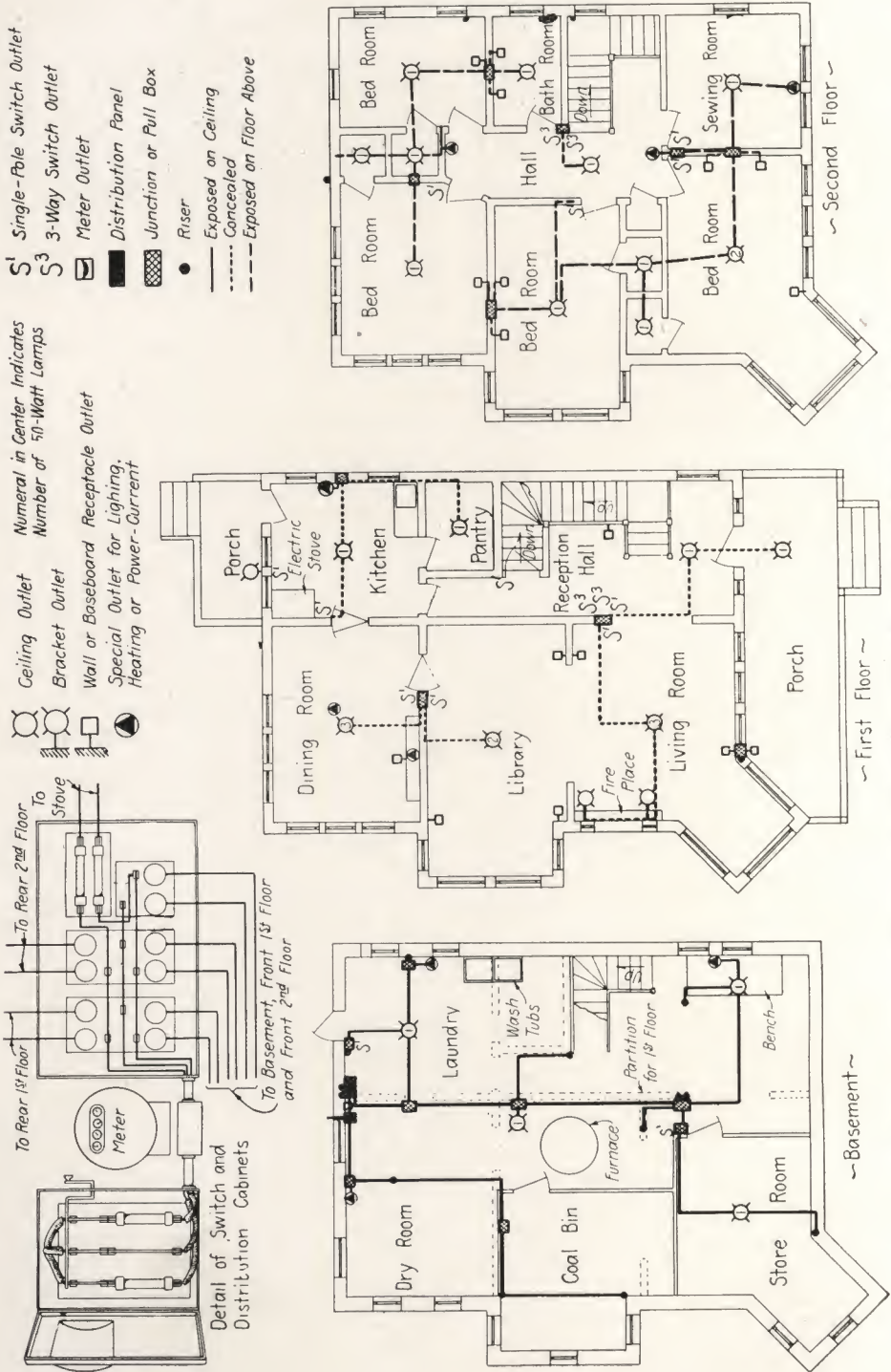
The question then arises, What is a good wiring installation? This has already been partly answered in reference to the provision of ample outlets. These outlets must be served by wire of abundant capacity to safely carry whatever current is required by the appliances that may be used and the wire must be thoroughly insulated to guard against danger of fire or electric shock. Moreover, the wiring system must be installed so as to remain safe against these dangers. In all but a few cases it should be installed so as to be inconspicuous, that is, it must be concealed. This last requirement is what introduces the element of danger because certain wiring systems may have their safety factor lowered thereby.

Early use of wooden molding wiring was gradually abandoned because it was unsightly and the molding deteriorated due to warping and knocks, thus often causing fires. Concealed wiring on the knob and tube system was then introduced; this consisted in running the wires through the hollow partitions and floors, the wires being supported on porcelain knobs and run through insulating bushing tubes when passing through joists or timbers. This makes a good system, if carefully installed, and in a house that is not likely to have partitions altered or opened up for plumbing or other repairs

In cities, houses and apartments are quite frequently altered and repaired, at which time a careless carpenter or other non-electrical workman may saw into or otherwise damage the insulation of the wires, thus introducing a hazard. For this reason knob and tube wiring is not permitted in many cities, the requirement there being that the wires must be protected by conduit or steel armor to guard against subsequent damage.

The conduit wiring system has the advantage

of not only permanent protection for the wires, but may be arranged so as to permit the wires to be later withdrawn and replaced by larger ones, if a heavy heating load, for instance, is added at some future time. Again, the conduit may be installed for such heavy circuits and the wires later drawn in when the electric range or other heavy appliance is added. For these various reasons conduit wiring is coming into extensive use in residences. In spite of its higher cost, it makes the most satisfactory installation.



Wiring Diagrams for Basement, First and Second Floors of a Typical Residence Wired Entirely in Conduit

## Wiring of Farm Buildings

### Need for Large Wire for Low-Voltage Lighting Plants— Useful Chart for Finding Proper Wire Size

*From Electrical Review*

During the last two years the steadily increasing prosperity of the farmers has resulted in an extraordinary increase in the number of farms equipped with electric lighting plants of the self-contained type, including gasoline engine, dynamo, switchboard and usually a storage battery. On account of the latter being more practical with as few cells as possible, it is usual to have these plants designed for 32 volts, 16 cells of lead battery or 24 cells of Edison storage battery being then used.

In wiring the farm house and adjoining buildings the use of this lower voltage requires special consideration. This is primarily because at 32 volts a certain load, say 110 watts, requires  $3\frac{1}{2}$  amperes, whereas the same load at the standard pressure used in cities (110 volts) requires only 1 ampere. To accommodate this current of  $3\frac{1}{2}$  times what is used in city-residence wiring for similar loads evidently requires much larger wire.

If this larger wire is not used, but the premises are wired with No. 14 B. & S. wire as in the city, two serious difficulties arise. First, the lights at a distance from the generating plant will burn dim, due to the large voltage drop in the wires, which increases directly with the current and with the distance. Second, if an attempt is made to use a 30-volt flatiron or other heavy load on No. 14 wire, dangerous heating may take place because the current may be 18 to 20 or more amperes, which is considerably above the allowable safe carrying capacity of rubber-insulated No. 14 wires. If the appliance or other heavy load is not close to the plant, the probability is that the excessive voltage drop in the wiring will make it difficult to get proper service out of the iron or other load.

As a guide to the proper size wire to be used in such plants a very handy wiring chart has been prepared by the Engineering Department of the National Lamp Works of General Electric Co., Nela Park, Cleveland, Ohio. It is reproduced herewith. To use the chart is very simple. Assume, for example, that a load of 280 watts is to be supplied at a distance of 110 feet, so that about 225 feet of single wire will be needed both ways. A dotted horizontal line is shown for 280 watts crossing a dotted vertical line for 225

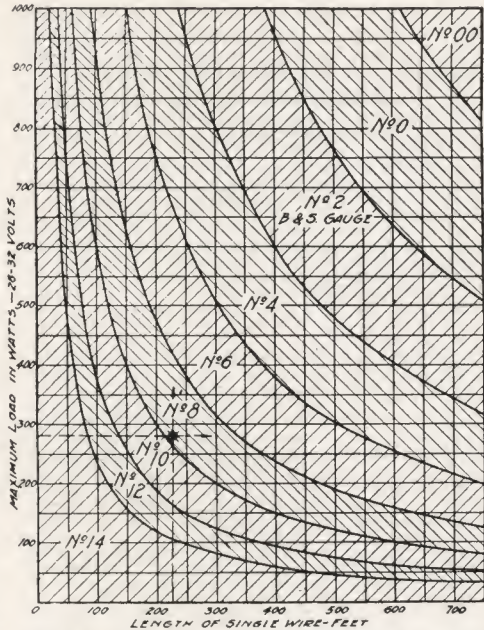


Chart for Finding Proper Wire Size in Wiring for Lights and Small Motors Supplied from a 28 to 32 Volt Generating Plant.

feet in an area marked No. 8; this means that No. 8 wire is necessary in this case. In the same way any other load and distance likely to be dealt with can be checked up as to proper wire size.

It is interesting to note that No. 14 wire can be used for a small load, say 100 watts, only up to 240 feet, whereas for the same 100-watt load it will require No. 12 wire at 300 feet, No. 10 wire at 500 feet, and No. 8 at 700 feet. Likewise for a distance of 100 feet a load of 200 watts can be accommodated by No. 14 wire, but a load of 300 watts requires No. 12, a load of 400 requires No. 10, and so forth.

## Industrial Plant Wiring

### Requirements of Factory Wiring—Selection of Most Suitable Wiring System—Relative Advantages of Open and Conduit Wiring—Layout of Light and Power Circuits

The rapid industrial development of recent years has been accompanied by extensive electrical equipment of factories, mills and shops. This electrification of industrial plants has concerned itself principally with conversion of mechanical to motor drive, also with adoption of electric lighting and, more recently, with use of electric furnaces, ovens, welding equipment and other special electric heating applications. All these and other electrical applications call for suitable wiring systems and the installations of these systems has therefore made factory wiring a more varied and difficult problem than was the case a decade or so ago.

Factory wiring does not often have to be concealed, nor does it have to be so neatly installed as in a residence, for example. Its installation is not on this account as simple as it seems, however. Its primary requirement is to serve as the reliable means of furnishing energy to motors, lamps, heating devices, etc. Power is one of the chief requisites in modern manufacturing; having provided a reliable source of electric power, the wiring for distributing it about the plant must be at least as dependable. The second requirement of the wiring is that it must be safe and free from fire or accident hazards because of the large number of employees that may be at work in the plant and of whom only very few know much about electricity and how to guard against shock or fire from its use. It is in order to provide safety from these hazards that the rules governing factory wiring in the national and local electrical codes have steadily been made more stringent.

There are two principal wiring systems used in factory buildings: (1) Open wiring, in which the insulated wires are supported on porcelain knobs or cleats and are not enclosed in any protection except where exposed to probable injury and (2) conduit wiring, in which the wires are run in metal ducts that are either exposed on the ceilings, walls or columns, or concealed in the walls and floors, or partly exposed and partly concealed. Conduit wiring is obviously more expensive, but much safer and more reliable because the wires are completely protected from mechanical injury, from accumulations of dust, etc. Because of its superior safety, conduit wiring is insisted on for factory buildings in the largest cities and is coming more and more into use everywhere.

Selection of the wiring system depends on the nature of the building construction and on the character of the manufacturing process carried on. In general, it may be said that the less expensive open wiring system may be used in any factory building where no special effort at fireproofing has been made and in which no hazardous materials or processes are used and further, where the wires may be so arranged that they

will not be readily disturbed. If the building is of substantially fireproof construction, open wiring is entirely out of place because every feature of the wiring also should be practically fireproof. If so-called mill construction is used, open wiring may be used with slow-burning insulation on the wires. Conduit wiring may be used in almost any type of building, but is especially desirable in concrete or other fireproof buildings. In factories or mills where explosive or other hazardous materials are being handled conduit wiring is absolutely essential. Examples are flour mills, grain elevators, powder plants, certain chemical works, oil works, many textile mills, etc.

After the kind of wiring system has been selected, several precautions should be observed in laying out the system in order to promote economy in first cost of installation and in making future additions; this is especially important in concealed conduit systems. Circuits should be run as direct and as free of bends as possible. All wires for a circuit should be run in the same conduit, especially if alternating current is used. Distribution, junction, cutout and switch boxes or cabinets should be of ample size to accommodate additional feeders and branch circuits that it may be anticipated to add later, even if these are not installed for some time. This may be easily done by having these boxes of ample size, and provided with blank knockouts to permit ready addition of other feeders or branches without interfering with existing service. If such provision is neglected, troublesome interference, delay and much extra expense may be involved when the additional circuits are needed. In the case of concealed conduit in a concrete building it pays to install ample conduit runs for any possible future demands because of the obvious cost and trouble to put in extra conduit unless the latter is exposed. Wire may be pulled into such extra conduit whenever needed.

Separate feeders should always be installed for lighting and power. The first reason for this is that starting and stopping of motors causes serious fluctuation of the circuit voltage; large changes of load also produce such fluctuations, which are very noticeable in the light emitted by lamps. Flickering light is very annoying to the eye and may produce errors or accidents. The second reason is that motor circuits are more often overloaded or short-circuited, and therefore interrupted by blowing of fuses, than lighting circuits. Any combination of lighting and power circuits on the same feeder is therefore liable to cause troublesome cutting off of the light that might lead to confusion, accidents or even panic, if many or if easily terrified women employees were involved in a large shop.

In laying out the lighting circuits, the illumination requirements of the different rooms must first be known. These depend on the kind of work done, the size and light-absorbing conditions of the room and on the nature of the lighting equipment selected. On account of the variables the power consumption for lighting ranges from 0.5 to 2.5 watts per square foot in different departments of different plants. For any chosen lighting intensity and related conditions it is possible to find the corresponding unit watt consumption. Assume it to be 1.2 watts per square foot. The floor area in square feet multiplied by 1.2 will then give the total wattage to be provided for the room in question. Not more than 660 watts is allowed on any ordinary lighting circuits. From these facts it is possible to lay out the requisite circuits, the arrangement of which in a large room should usually permit switching on the lamp in rows parallel to the windows, so those farthest from the windows may be turned on first.

The accompanying table shows the capacity of different sizes of wires as lighting feeders. The second column gives the capacity of the wire in amperes, the third column gives it in watts based on 220 volts between the outer wires. The last six columns give the number of 25, 40, 50, 60, 75 and 100-watt lamps, respectively, that can be supplied by the particular size of wire. The neutral wire is not taken into account, serving chiefly as a means for overcoming unbalance. These capacities have nothing to do with the branch circuits, which are normally limited to 660 watts.

Since failure of the light at a critical time, as at the outbreak of a fire, might easily contribute to serious loss of life in a factory with many employees, because of the great difficulty in finding exits in a dark, smoke-filled room, a number of communities require installation of an independent system for emergency lighting. This is an excellent provision in any medium size or large plant. Such a system should have separate circuits and be fed from a source separate from that normally supplying the lighting. If the plant has its own power house, the emergency lighting should be fed from a central station or other external source. If the plant uses central-station supply, a separate service should furnish the emergency lighting. This lighting should include all exit and stairway lights and enough special lights on each large floor to permit finding the way to the nearest exit.

Laying out of the power circuits where there are many motors and of different sizes is often a difficult problem. Since the power load is almost invariably many times greater than the lighting load in a factory, even greater care in laying out the power feeders and branch circuits is necessary than for the layout of the lighting, because not only would there be a waste in first cost of unnecessary length of heavy cable or wire but also in needless power loss in overcoming resistance.

Rules for finding the size of wire to run to any motor are quite well known and many tables have been published both for direct-current and alternating-current motors. It is usual to allow not only for the efficiency of the motor, but

also for at least 10 per cent over full-load current because the starting current, though usually of brief duration, is frequently three times the full-load current. Obviously, if the motor is started at short intervals, or if it is subjected to frequent overloads, the wire size has to be larger, else overheating of the conductors would ensue. The kind of service the motor is to render, the type of the motor and its rating must be taken into account in determining the wire size.

There are conflicting rules and opinions about the sizes of mains supplying more than one motor. Insurance inspectors are inclined to require a heavier size of main than many municipal or central-station inspectors. Among the former a common rule is to have the main provide for 110 per cent of full load for the largest motor plus full load for the other motors of the group. Other inspectors are inclined to allow for the demand-factor of the motor group; this usually permits of a smaller wire size and is legitimate, provided the prospective demand-factor is definitely known and remains so after installation. On account of the uncertainty of this it is better to be on the safe side and provide mains of ample size to prevent overheating, which is not only dangerous but represents needless power loss and reduced voltage and speed for the motors.

In some large plants motor mains are run on the ceiling to a junction box, from which the branch circuits are dropped to the individual motors. This is economical of wire, but requires fuses in the junction box, which is here located in a relatively inaccessible place, so that blowing of a fuse may represent much delay before the motor can be put back in service. It is preferable to run the mains as risers to distributing boxes or panels on the wall or columns where fuses may be quickly replaced.

For all but small motors over a minimum that depends on the type of motor, kind of service it performs and the source of supply, it is necessary to provide a starting rheostat, compensator or other starting device to permit the motor to come up to speed gradually without drawing an excessive starting current. This starter should be placed as convenient to the control point as possible; if it is at some distance from a large motor, an automatic remote-control system may save considerable heavy wiring. The starting device must have an automatic no-voltage release to prevent possible burnout of the motor if power is suddenly restored while the motor switch and circuit is closed. Stopping of the motor should preferably be by opening the main switch, which may be done by remote control from several stations about the driven machine.

Installation of an open wiring system is relatively simple. The wires must have either a rubber, slow-burning or slow-burning weather-proof insulation; rubber-covered wires smaller than No. 6 may have a single outer braid, but No. 6 or larger must have a double braid. In very moist rooms rubber insulation is required. In places where there are corrosive vapors, the insulation may be either rubber or weather-proof; in the latter case a coating of shellac or

varnish is sometimes applied over the wires after they have been put up. In all cases the wires must be properly supported and spaced. Where exposed to mechanical injury they must be protected by conduit, running boards or guard strips.

Installation of conduit wiring is not very difficult when done by a skilled wireman. Rubber-covered wiring is used almost exclusively, unless the temperature of the room is quite high when slow-burning insulation is required

In places where there is liability for condensation inside the conduits due to changes of temperature, as in cold-storage or refrigerating rooms, the conduit must be well drained or open wiring with suitable guard strips where necessary must be used. The growing use of conduit systems in industrial plants is causing electricians quite generally to gain the requisite experience and skill needed for its proper installation. Its almost universal use in the future is therefore to be expected.

CAPACITY OF WIRES FOR LIGHTING FEEDERS

Size American Wire Gauge (B. & S.)	Ampere capacity	Feeder wattage	3 Wire System, 220-110-220					
			Lamp Wattage					
			25	40	50	60	75	100
14	15	3,330	132	82	66	55	44	33
12	20	4,400	176	110	88	73	58	44
10	25	5,500	220	137	110	91	73	55
8	35	7,700	308	192	154	128	102	77
6	50	11,000	440	275	220	183	146	110
4	70	15,400	616	385	308	256	205	154
3	80	17,600	704	440	352	293	234	176
2	90	19,800	792	495	396	330	264	198
1	100	22,000	880	550	440	366	293	220
0	125	27,500	1,100	687	550	458	366	275
00	150	35,000	1,320	825	660	550	440	330
000	175	38,500	1,540	962	770	641	516	385
0,000	225	49,500	1,980	1,237	990	825	660	495
250,000 C. M.	240	52,800	2,112	1,320	1,056	880	704	528
300,000	275	60,500	2,420	1,512	1,210	1,008	806	605
350,000	300	66,000	2,640	1,650	1,320	1,100	880	660
400,000	325	71,500	2,860	1,787	1,430	1,191	953	715
450,000	372	81,840	3,272	2,040	1,636	1,364	1,090	818
500,000	400	88,000	3,520	2,200	1,760	1,466	1,173	880
550,000	425	93,500	3,740	2,337	1,870	1,558	1,246	935
600,000	450	99,000	3,960	2,475	1,980	1,650	1,320	990
650,000	475	104,500	4,180	2,612	2,090	1,741	1,393	1,045
700,000	500	110,000	4,400	2,750	2,200	1,833	1,466	1,100
750,000	525	115,500	4,620	2,887	2,310	1,925	1,540	1,155
800,900	550	121,000	4,840	3,025	2,420	2,016	1,613	1,210
900,000	600	132,000	5,280	3,300	2,640	2,200	1,760	1,320
1,000,000	650	143,000	5,720	3,575	2,960	2,383	1,906	1,430
1,250,000	750	165,000	6,600	4,125	3,300	2,750	2,200	1,650

# Labor Cost For Installing Conduit Wiring Systems

## Abstract of Report Presented by Electrical Estimators' Association of Chicago Before Convention of National Association of Electrical Contractors and Dealers

Electrical contractors and others interested in electrical construction work have found that estimating of the material to be used in a proposed building is relatively easy because the quantities can be quite definitely determined and the market prices are readily ascertained. Estimating of the labor cost is much more difficult, however, because of the many personal elements involved.

Estimating labor will always be the personal judgment of the estimator based on his own experience and what he is able to learn from the experience of others. The estimator is largely responsible for the standards of the business in which he is engaged. It then becomes his duty to give forth the benefit of his experience to others engaged in the same work in order to enjoy the benefits of their experience, and in return to distribute this knowledge received so that all estimators will have a more definite knowledge of what it costs to install the various branches of the work.

Within the past year this broad view of the responsibility of the estimator has led to the organization of electrical estimators, an outcome of which was the compilation, for the first time, of comprehensive and reliable data on labor costs. These data were gathered by the Electrical Estimators' Association of Chicago and are based on records covering many years' experience of its members in checking electrical construction work under different conditions. The report on this subject was presented before the Cleveland convention of the National Association of Electrical Contractors and Dealers, by which the data were declared to be the most dependable ever compiled on the subject.

The essence of the report is contained in the seven tables and two curve sheets reproduced herewith. The data cover the labor cost of installing conduit wiring systems in two average types of buildings—(A) mill construction with exposed (open) conduit and some simple concealed work, and (B) fireproof construction with exposed conduit and some difficult concealed work. These data cover average con-

ditions in the two types of buildings and are based on hundreds of individual records so as to be truly representative. If the difficulties to be encountered in any proposed building are likely to be greater or much less than the average with these two classes of structures, the unit labor cost must be increased or decreased proportionately.

Since labor costs depend on the wage scale, a standard has to be adopted for any comparative figures. The data in the tables are based on a wage of \$7 per day, which was the scale in effect in Chicago when the cost data were compiled. For any higher or lower wage scale, the unit costs must be correspondingly raised or lowered.

Table 1 gives the cost per foot of installing different sizes of conduit, also the cost of installing various common sizes of elbows in the two types of buildings; it also gives the quantity installed per man per day. Table 2 gives the unit cost and average unit time for installing different kinds of outlet and switch boxes, cut-out boxes and other special roughing-in work. Table 3 gives unit costs for drawing in wires of different size when there are 1, 2 or 3 wires in the conduit, also the length of wire drawn in per day; in wires over No. 4/0 B. & S., the size is given in thousands of circular mils. Table 4 gives the cost of the finishing work of placing and connecting fixtures, switches, receptacles, meters, etc.; the unit time and number set per day are also given. In Table 5 is given the unit cost, time and number finished per day of soldering terminal lugs in heavy wires and cables. Tables 6 and 7 give the unit cost and time of erecting motors and of setting and connecting of the starting device to the motor and circuit; in motor erection both floor and ceiling mounting are covered; in motor and starter connection separate tables are given for direct-current and alternating-current equipment.

The first curve sheet shows graphically the data of the upper part of Table 1. The second curve sheet shows graphically the data for pulling in 1, 2 or 3 wires in a duct, that is, the group of cost columns of Table 3.

TABLE 1—ROUGHING IN CONDUIT AND ELBOWS

Conduit Size Inches	Cost per Foot at \$7.00 per Day		Feet per Day per Man		Conduit Size Inches	Cost per Foot at \$7.00 per Day		Feet per Day per Man	
	A.*	B.†	A.*	B.†		A.*	B.†	A.*	B.†
1/2	\$0.05	\$0.09	140	78	2	\$0.215	\$0.215	33	33
3/4	.065	.10	108	70	2 1/2	.275	.275	26	26
1	.09	.12	78	58	3	.34	.34	21	21
1 1/4	.125	.14	56	50	3 1/2	.42	.42	17	17
1 1/2	.16	.17	44	40	4	.50	.50	14	14

Elbows	Cost per Elbow		No. per Day Per Man		Elbows	Cost per Elbow		No. per Day	Per Man
1	\$0.15	\$0.20	46	35	2½	\$0.75	\$0.75	9	9
1¼	.20	.25	35	28	3	1.00	1.00	7	7
1½	.35	.40	20	17	3½	1.50	1.50	5	5
2	.50	.50	14	14	4	2.00	2.00	3	3

\*A—Open pipe, mill construction and simple concealed work.

†B—Open pipe, fireproof construction and difficult concealed work.

Add extra labor for cutting, openings, channeling, and other conditions requiring same.

BX-14—Per foot 10c; 70 ft. per day.

TABLE 2—ROUGHING IN CONDUIT FITTINGS

NON-FIREPROOF	Labor—\$7.00 Rate		Time	
	A	B	A	B
Ceiling outlets.....	\$0.15	\$0.30	0-10'	0-21'
BK., SW., and B. P. outlets.....	.20	.40	0-14'	0-27'
T-fix. hanger.....	.50	.75	0-34'	0-51'
¾ fix. stud.....	.05	.08	0-03'	0-05'
Floor box.....	1.50	2.00	1-42'	2-18'
FIREPROOF				
Ceiling outlets.....	.40	.50	0-28'	0-34'
BK., SW., and B. P. outlets.....	.50	.70	0-34'	0-48'
Suspended outlets.....	1.00	1.50	1-09'	1-42'
Floating outlets.....	.75	1.00	0-51'	1-09'
T-fix. hanger.....	.75	1.00	0-51'	1-09'
Floor box.....	2.00	3.00	2-18'	3-27'
CHANNELING PER FOOT				
Soft brick.....	.20	.30	0-14'	0-21'
Green concrete.....	.25	.35	0-17'	0-24'
Set concrete.....	.30	.40	0-21'	0-27'
¼"x1¼" EXP. BOLTS				
Soft brick.....	.10	.15	0-07'	0-10'
Green concrete.....	.15	.20	0-10'	0-14'
Set concrete.....	.20	.30	0-14'	0-21'
LIGHTING C. O. B.				
Per circuit.....	.50	.75	0-34'	0-51'

For service switch and power C. O. B. labor see lug rule. Double labor for bricked in outlets.

TABLE 3—FINISHING LABOR

American Wire Gauge (B. & S.)	Cost per Foot of Each Wire Labor—\$7 per Day			Feet per Day per Man		
	1 Wire	2 Wire	3 Wire	1 Wire	2 Wire	3 Wire
No. 14 dup.....		\$0.01	....		700	....
No. 14.....		.0055	\$0.005	...	1,275	1,400
No. 12.....		.007	.006	...	1,000	1,166
No. 10.....		.009	.008	...	777	875
No. 8.....		.013	.01	...	538	700
No. 6.....		.015	.012	...	466	583
No. 4.....		.018	.015	...	390	466
No. 3.....		.022	.018	...	320	390
No. 2.....		.027	.02	...	260	350
No. 1.....		.03	.023	...	233	305
No. 0.....	\$0.05	.037	.028	140	190	250
No. 2/0.....	.06	.042	.033	116	166	212
No. 3/0.....	.07	.05	.037	100	140	190
No. 4/0.....	.085	.06	.043	82	116	163
300 M.....	.10	.07	.05	70	100	140
400 M.....	.12	.085	.06	58	82	116
500 M.....	.145	.10	.073	48	70	96
600 M.....	.165	.115	.08	42	61	87
700 M.....	.18	.125	.087	39	56	80
800 M.....	.19	.135	.093	37	52	75
900 M.....	.195	.138	.097	36	51	72
1,000 M.....	.20	.14	.10	35	50	70

Intercommunicating telephone cable labor ¼c per foot for each conductor. Average length of pipe run for feeders, 100 feet.

**Table 4—Finishing Up Labor on Wire Fittings**

	Labor \$7.00 Rate	Time		No. per Day
		Hrs.	Min.	
S. P. switches.....	\$0.25	0	17	28
D. P. switches.....	.35	0	24	20
3 and 4-way switches.....	1.40	1	36	5
Door switches.....	1.75	2	00	4
Base plugs.....	.30	0	21	24
Cover sockets.....	.25	0	17	28
Drop cords.....	.40	0	27	18
1-light factory fixture.....	.70	0	48	10
Lighting pan, per circuit.....	.35	0	24	20
No. 10 wire lighting ground.....	1.00	1	09	7
No. 4 wire lighting ground.....	1.40	1	36	5
No. 10 wire motor ground.....	.60	0	42	12
No. 4 wire motor ground.....	1.00	1	09	7
30A—2-wire meter loops.....	1.00	1	09	7
30A—3-wire meter loops.....	1.20	1	22	6
60A—3-wire meter loops.....	2.50	1	42	3
100A—3-wire meter loops.....	5.00	3	24	1
30—60 A-2 W. meter.....	1.00	1	09	7
30—60 A-3 W. meter.....	1.20	1	22	6
60—100 A-2 W. meter.....	1.75	2	00	4
60—100 A-3 W. meter.....	2.35	2	41	3
Bells setting and testing.....	.50	0	34	14
Push buttons, setting and testing.....	.50	0	34	14

Intercommunicating telephones, connecting, setting and testing, allow 20c per wire connection or 35 connections per day.

**Table 5—Cost of Soldering Lugs**

Amperes Lug	Size of Wire	Rate \$7.00	Time,		No. per Day
			Hrs.	Min.	
30.....	No. 8	\$0.18	0	12	38
50.....	No. 6	.25	0	17	28
60.....	No. 4	.30	0	21	23
75.....	No. 3	.35	0	24	20
100.....	No. 1	.40	0	27	17
150.....	No. 00	.50	0	34	14
175.....	No. 000	.55	0	38	13
200.....	No. 0000	.60	0	42	12
250.....	300 M	.65	0	45	11
300.....	350 M	.75	0	51	9
340.....	400 M	.90	1	03	8
400.....	500 M	1.00	1	09	7
500.....	700 M	1.20	1	22	6
600.....	800 M	1.30	1	30	5
700.....	900 M	1.40	1	36	5
800.....	1,000 M	1.50	1	42	5
1,000.....	1,500 M	2.00	2	18	3

For wire terminals, not requiring lugs (Nos. 14, 12, 10 and 8 wire), labor 10c per wire connection. Lug Rule.—For total labor setting distributing cabinets with panels, and knife switches and cabinets, double the cost of labor for soldering lugs.

**Table 6—Labor Erecting Medium-Speed Motors**

H. P.	Erecting Motors at \$7.00 Rate		Erecting Motors Time in Hrs. and Min.	
	Floor	Ceiling	Floor Hrs. Min.	Ceiling Hrs. Min.
1 to 3.....	\$ 3.50	\$ 7.00	4 00	8 00
5.....	5.00	10.00	5 43	11 25
7.5.....	7.00	11.00	8 00	12 34
10.....	8.00	12.00	9 06	13 42
15.....	10.00	15.00	11 25	17 08
20.....	12.00	20.00	13 42	22 50
25.....	14.00	25.00	16 00	28 33
30.....	18.00	30.00	20 34	34 16
40.....	21.00	45.00	24 00	51 23
50.....	24.00	60.00	27 25	68 32
75.....	35.00	.....	40 00	.. ..
100.....	40.00	.....	45 40	.. ..
125.....	50.00	.....	57 06	.. ..
150.....	60.00	.....	68 32	.. ..

Values based on ground-floor handling.

Motors to be handled without special equipment.

Add extra labor for motor supports.

Extra labor to be added for hoisting above ground floor.

**Table 7—Labor Connecting Medium-Speed Motors**

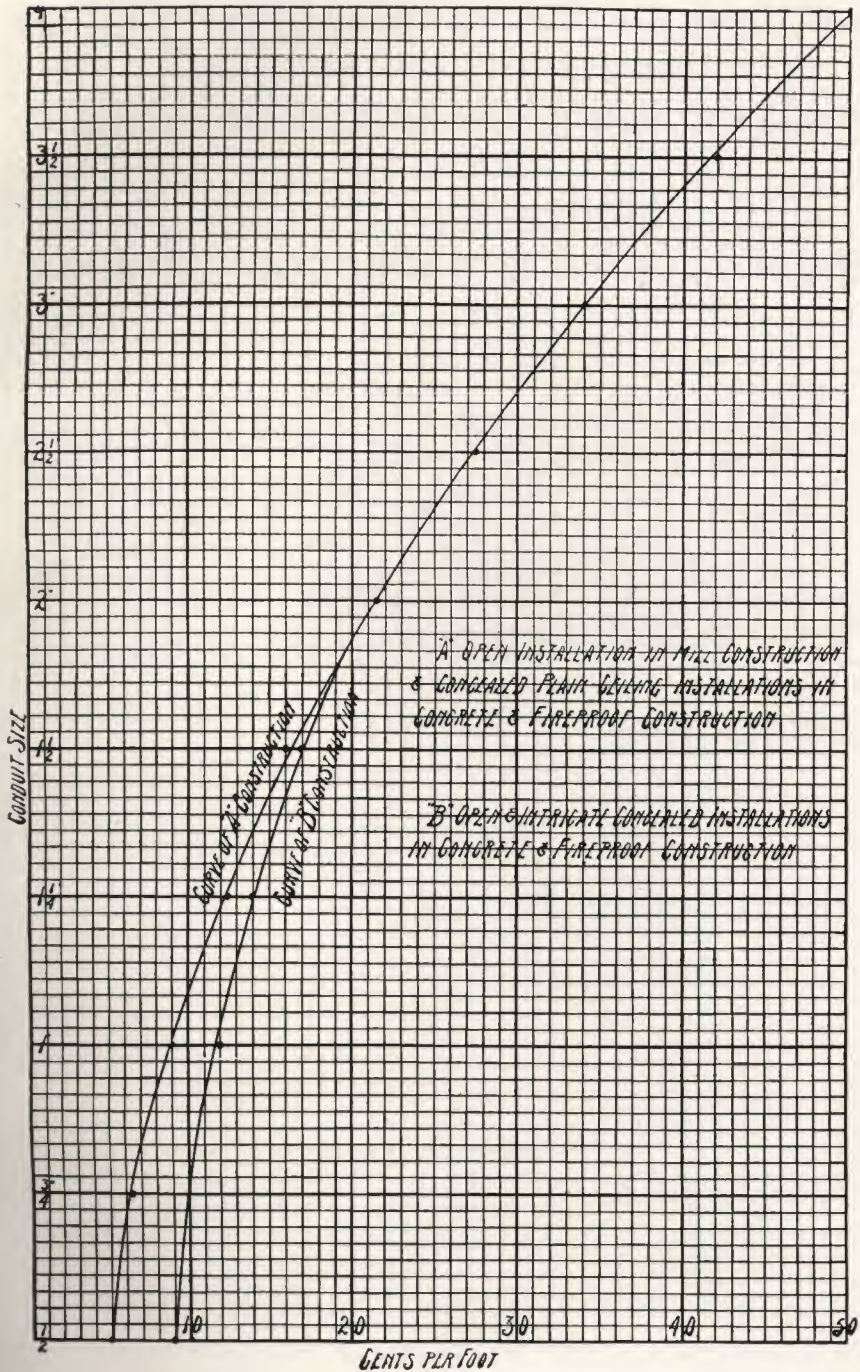
H. P.	Setting Starter and Connecting Motor at \$7.00 Rate		Setting Starters and Connecting Motors. Time in Hrs. and Min.	
	D.C.	A.C.	D.C. Hrs. Min.	A.C. Hrs. Min.
1 to 3.....	\$ 3.50	\$ 2.00	4 00	2 17
5.....	4.00	2.50	4 34	2 51
7.5.....	5.00	7.00	5 43	8 00
10.....	6.00	8.00	6 51	9 06
15.....	7.50	10.00	8 34	11 25
20.....	9.00	12.00	10 17	13 42
25.....	10.00	14.00	11 25	16 00
30.....	11.00	15.00	12 34	17 08
40.....	13.00	16.50	14 51	18 51
50.....	14.00	18.00	16 00	20 34
75.....	17.00	23.00	19 25	26 16
100.....	20.00	26.00	22 50	29 42
125.....	24.00	30.00	27 25	34 16
150.....	25.00	40.00	28 33	45 40

Add 50 per cent extra labor for slip-ring motors, simple starter.

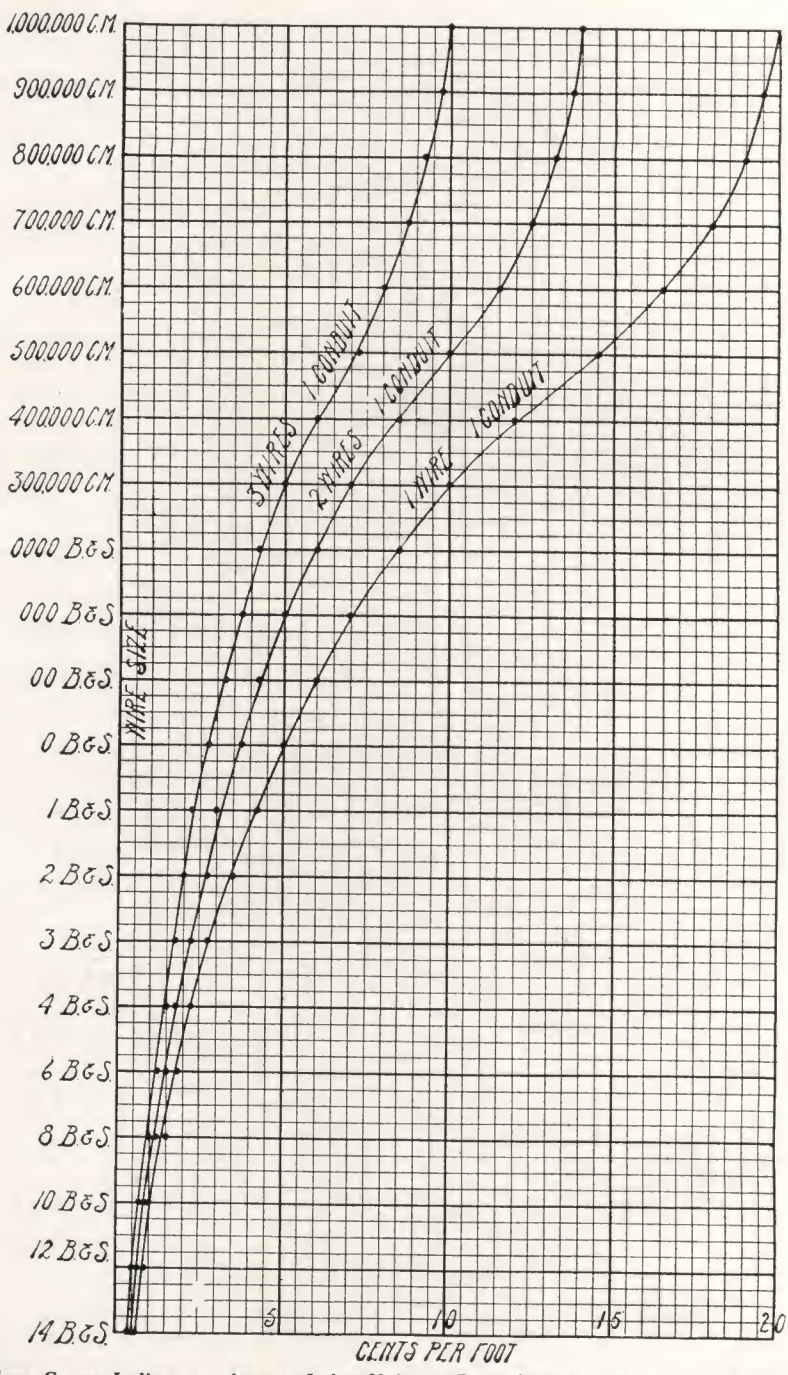
Add extra labor for starter supports.

Use lug rule for setting and connecting motor control switch.

(Under this rule figure the same amount of labor for setting cabinet and panel or switch as allowed for soldering lug connections attached to same.)



These Curves Indicate an Average Labor Unit for Installing Conduit Under Average Working Conditions



These Curves Indicate an Average Labor Unit per Foot of Wire to Pull Same in Conduit.

# Protective Grounding of Lighting and Power Circuits and Equipment

## Necessity for Grounding—Location of Circuit and Equipment Grounds—Method of Grounding—Requirements of Ground Wires

Grounding or earthing is the connecting of an electric circuit or apparatus to the earth, either for making the earth form one of the conductors of the circuit normally (as in telegraph, telephone or other signal work) or for protecting the circuit or apparatus and also persons liable to come in contact therewith, from lightning or other serious excess voltage. This latter is known as protective grounding and is steadily receiving greater attention, as shown by the revision and amplification of the grounding rules of the National Electrical Code in the latest (1918) edition. The following discussion deals only with protective grounding of ordinary lighting and power circuits and equipment.

The insulation on circuit wires and the conducting parts of electrical apparatus is designed for a reasonable excess over the normal voltage, but it is impracticable to provide circuits or devices with sufficient insulation to protect against the high voltage that might be imposed upon them by being crossed, during a storm for instance, with high-tension power or primary distribution lines or otherwise exposed to very abnormal potential. Grounding of the circuit is therefore resorted to in order to protect persons (and also the insulation) from being subjected to a voltage to the ground that is higher than the normal voltage to ground of the circuit. If the circuit supplying the building is not exposed to leakage or induction from high voltages, grounding is not necessary; this is usually true in isolated plants or buildings supplied from underground direct-current circuits.

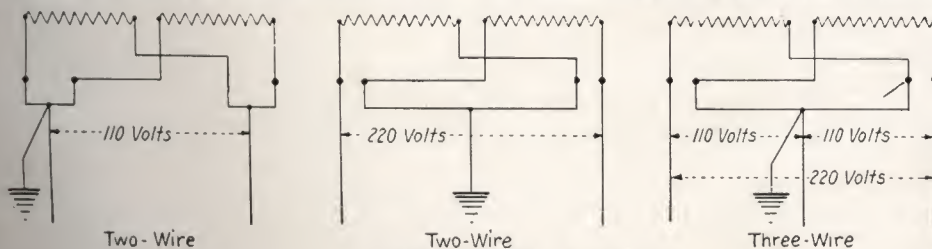
In bath rooms, in rooms with wet or conducting floors, or in the vicinity of plumbing fixtures and other well grounded surfaces it is often possible to get a serious shock when touching lighting fixtures in which the insulation of socket linings, bushings, etc., has deteriorated and thus permitted the outer metal shell to become "alive" through contact with one side of the circuit. Grounding of fixture and socket casings is the best way to overcome this, although an alternative is to use porcelain or

composition sockets on heavy pendants; that is either have the metal casing at ground potential or use a non-conducting casing. In the same way the casings of conduit systems, armored cable, metal raceways, and the frames of motors and many other devices must be grounded because it is not practical to substitute non-metallic casings or frames for such equipment.

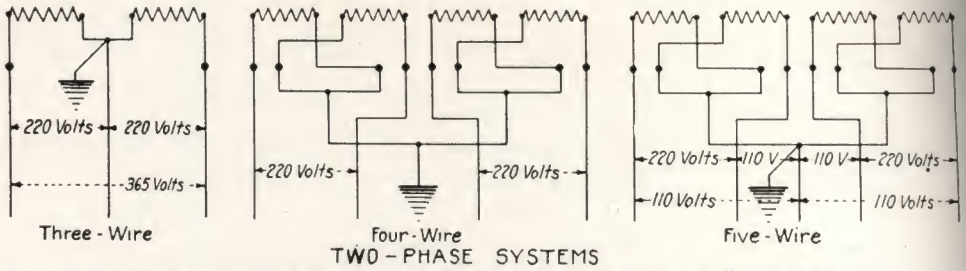
Direct-current supply circuits of the three-wire type must have the neutral wire grounded, as this reduces the liability of getting the full voltage of the outer wires on any branch circuit. Two-wire direct-current circuits need not necessarily be grounded, since they are usually not exposed to high voltages; but if they are grounded, it may be at either side so long as consistent throughout the system. Whenever direct-current circuits are grounded it is at the station only and not at individual service connections; this is to prevent electrolytic damage that would result from indiscriminate direct-current grounding.

Alternating-current secondary supply circuits (unless entirely unexposed to leakage or induction from high-voltage lines) must be grounded if the branch circuit voltage does not exceed 150 volts. Such circuits are usually supplied through a transformer, failure of which might impose the high primary voltage on the building circuits. The secondary lines may themselves become directly crossed with the primary or other high-voltage lines. Grounding the secondary overcomes this danger. If the normal secondary branch circuit voltage is above 150, however, it will itself give a serious shock, so that grounding in this case, while permissible, is not required.

Grounding of alternating-current circuits must be made at each building service or at a nearby transformer bank. In this case electrolytic danger does not exist and it is desirable to have a protective ground as near to the service connection as possible. The ground is placed on the neutral wire, if there is one, or at the most convenient point which at the same time gives the lowest voltage from ground of unguarded



Location of Ground Connection on Single-Phase Secondary Distribution Systems.



Location of Ground Connection on Two-Phase Secondary Distribution Systems

current-carrying parts of connected devices. Three of the accompanying diagrams show the point on the secondary as related to transformer bank that is grounded on one, two, and three-phase systems. In polyphase systems that phase that is used for lighting is usually grounded.

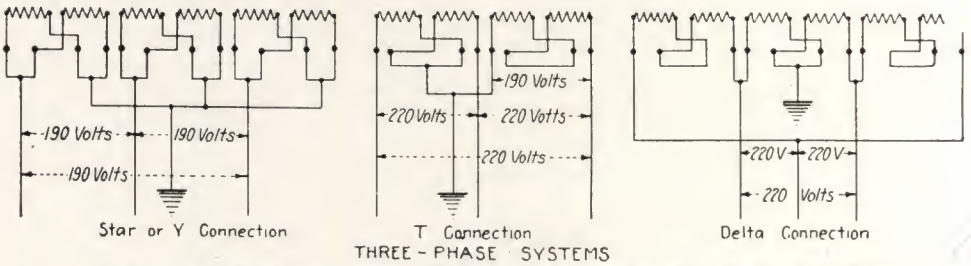
Grounds for conduit, armored cable and metal raceways must be near the point where the wires in the conduit or raceways receive their supply so as to most fully protect the entire interior system. If a service conduit is provided and the interior conduit is well bonded to it, the service conduit ground suffices for the entire interior system. The ground connection in all cases must be accessible for inspection and for service conduit and arrester grounds must be short and practically straight to afford the best possible discharge path for lightning or other high voltages.

Circuit grounds and equipment grounds must not carry any current in normal service, but be for protective use only. Continual passage of current would deteriorate the ground connection. Circuit grounds must be distinct from equipment grounds and also from lightning-arrester grounds, since deterioration or breakage of a common ground connection might cause circulation among different pieces of equipment of objectionable currents that should have gone direct to ground. Fuses must not be put in the grounded side of a circuit, as blowing of the fuse would destroy the protective grounding.

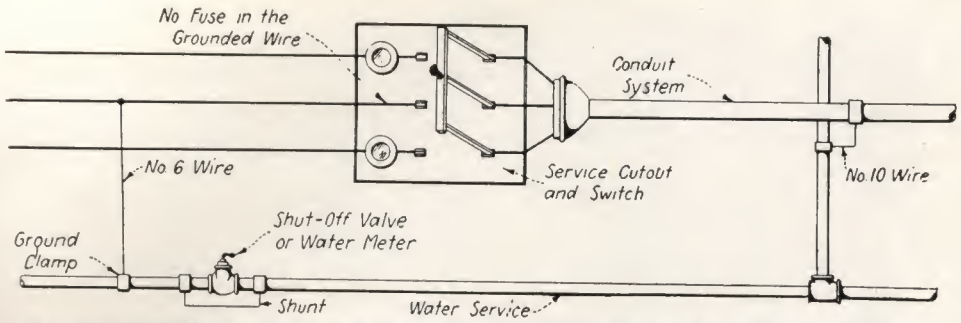
The best connection to ground is obtained by

connecting the ground conductor through an approved ground clamp with a well cleaned part of a water piping system. Such grounding is the most dependable and of lowest resistance; it is not injurious to the piping, especially on alternating-current systems. The ground wire must be soldered to the clamp and the connection must be protected from injury. The connection should be made on the street side of any water meter or shut-off, because removal of the meter or cutting off of the supply might make the inner piping considerably above real ground potential. If the connection must be made to the house side of the meter or shutoff, the latter must be suitably shunted. Connection to gas piping, except for equipment grounds, should be avoided because cemented joints are becoming more common. If connection to a water piping system is impossible, a so-called artificial ground must be used by connecting to a heavy copper or cast-iron plate buried below permanent moisture level; a pipe driven to permanent moisture or an equivalent ground to a deeply buried plate may be used, the object in all cases being to get the lowest permanent resistance to ground.

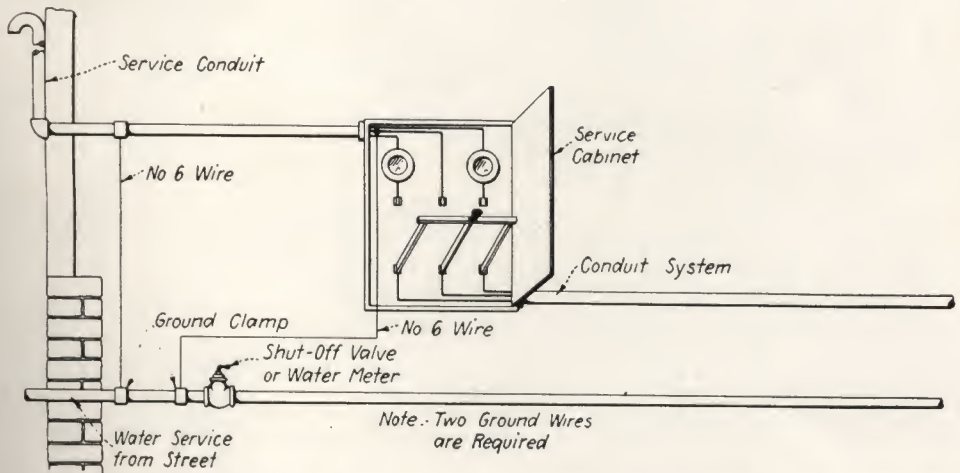
The ground wire must be of copper and of ample carrying capacity to render the protection necessary; it should be as straight and short as possible, and should be protected. For circuit grounds it must be at least as large as No. 6 B. & S. gauge. For equipment grounds it must be at least as large as No. 10 B. & S. gauge.



Location of Ground Connection on Three-Phase Secondary Distribution Systems



Method of Grounding the Service Wire and Interior Conduit System Where No Service Conduit is Provided



Note: Two Ground Wires are Required

Method of Grounding a Combined Service and Interior Conduit System and the Neutral Service Wire



**For**  
**Elevators**  
**Dredges**  
**Lumbering**  
**Mining**  
**Oil-Well**  
**Drilling**  
**Suspension**  
**Bridges**  
**Stump Pulling**  
**Cranes Derricks**  
**Ships' Rigging**  
**and**  
**Every Other Form**  
**of Wire Rope**  
**Use**  
*Ask for Illustrated*  
*Catalogue*

**American Steel & Wire Company's**  
**Trenton-Bleichert System**

## Aerial Tramways

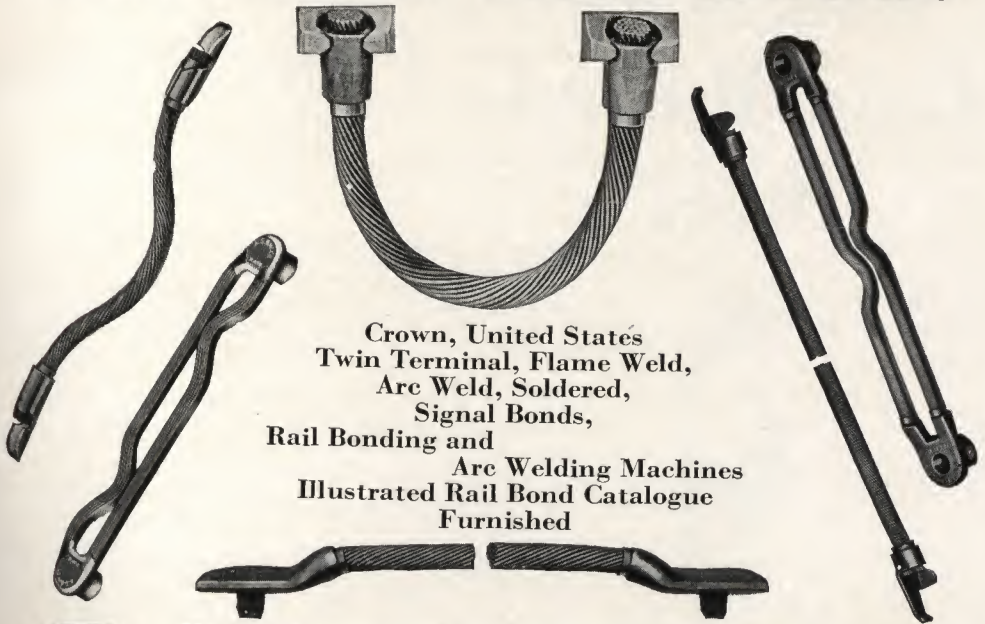
Every detail has been thoroughly worked out and we put into these constructions only material of the most approved and substantial kind, including

### American Wire Rope

No matter what the contour of the ground, we will construct a tramway that will transfer material in a bee line at minimum expense; and no grades are too steep to surmount; no rivers or valleys too wide to cross; and no grading, bridges or viaducts of any kind are required. There is practically no limit to the length of these tramways. We have one line carrying ore twenty-one miles.

*Send for Complete Descriptive Catalogue of Tramways in Use*

# American Rail Bonds



Crown, United States  
Twin Terminal, Flame Weld,  
Arc Weld, Soldered,  
Signal Bonds,  
Rail Bonding and  
Arc Welding Machines  
Illustrated Rail Bond Catalogue  
Furnished



Gas  
Welding  
Rods



PREMIER  
GRADE GA  
3-16  
FLAME TESTED  
A.S. & W.CO.

## PREMIER (TESTED) WELDING WIRES

Premier Welding Wire has been developed for dependable welding work. There are six Premier grades to meet your various requirements!

Free flowing and uniform in quality, Premier Welding Wires insure good fusion, thorough penetration and a permanently satisfactory weld of maximum strength.

Every bundle of Premier Welding Wire is electrically tested and manually welded before shipment in order to conserve gas, electricity and the welder's time. Send for booklet containing full information and specifications.

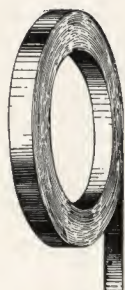


Electrodes

PREMIER  
GRADE E A  
5-32  
ARC TESTED  
A.S. & W.CO.



# Flat Wire Cold Rolled Steel



**I**N all widths up to 25 inches, for shaping into all forms of manufacture in automatic machines or otherwise, such as butts, hinges, tubes, roller skates, keys, typewriter, sewing, adding machines, and automobile parts, cream separator discs, buttons, stove and show case trimmings, gun parts, wire chair rims, go-cart parts and any difficult or plain forming where flat steel of great ductility, strength, finish and uniformity are required.

“Flat Wire Bulletin” mailed free.

# American Piano Wire

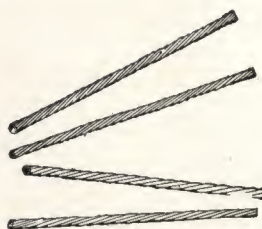
**PERFECTED  
CROWN**

Highest Acoustic excellence dating back to the days of Jonas Chickering. Took prize over whole world at Paris, 1900. For generations the standard and used on the greatest number of pianos in the world

Services of our Acoustic Engineer always available—free.

Illustrated books—free.

# American Wire Clothes Lines



Heavily coated with Zinc Smelter to withstand the effects of atmospheric conditions. Can be stretched permanently from post to post and will last for years. Eliminates trouble of taking down each wash day. Easily cleaned with a rag saturated with kerosene.

# Banner Poultry Fence

## Banner Standard

A square mesh Poultry fence of great strength, durability and handsome appearance at low cost. Top and bottom wires, No. 15 gauge; all other wires, No. 17 gauge.

## Banner Special

Its construction secures unlimited service in fencing all kinds of poultry from the chick to the grown fowl. Perfection galvanizing. Top and bottom horizontal wires, No. 13 gauge; intermediate horizontal wires, No. 15 gauge; upright wires or stays, No. 16 gauge.

## Banner Junior

A new light weight poultry fence—small spaces—tight knots. The close spacing insures safe protection for smallest chicks. Perfection galvanizing. Top and bottom horizontal wires, No. 16 gauge; intermediate horizontal wires, No. 18 gauge; upright wires or stays, No. 18 gauge.

## Banner Eclipse

A good reliable poultry fence. The very small spacing from bottom insures safe protection for poultry of all sizes. Perfection galvanizing. Top and bottom horizontal wires, No. 15 gauge; intermediate wires, No. 17 gauge; upright wires or stays, No. 17 gauge.

---

American Steel & Wire Company's

# Sulphate of Iron Process of Water Purification for Cities

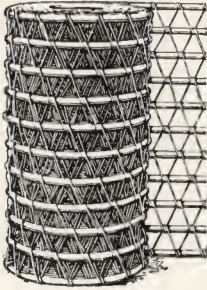
## The Standard System for American Cities

St. Louis	Cleveland	Evansville	Great Falls
Cincinnati	Ft. Worth	Oklahoma City	Fargo
New Orleans	Toledo	Paducah	Dallas
and hundreds of others			

Manual of Water Purification—free  
Services of our Engineering Department—  
Water Purification—always available

Also Sulphate of Iron for protection against hog cholera, worms and other diseases of swine and certain diseases of cattle and poultry. **Send for descriptive literature.**

# Wire Reinforcing Fabric

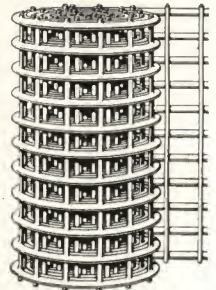


## Triangle Mesh Fabric

## Electric Weld Fabric

for buildings, pavements, roadways, building construction, levees, canal locks, chimneys, sewer pipe, viaducts, retaining walls, floor slabs, wall slabs and any other form of construction where concrete is used.

Send for books illustrating—free.



# Stucco Reinforcement



Galvanized Steel Fabric Reinforcing with its many angles of wire not only grips the cement tight, but reinforces it also, the principle being the same as reinforced concrete now used so extensively.

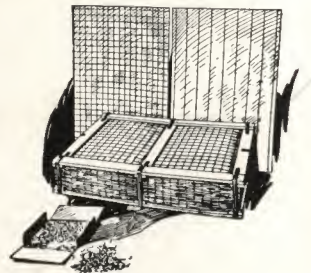
With its many galvanized steel wires imbedded in the cement, the wall becomes one unit—one solid mass of cement wall. That is what makes stucco strong and durable.

## *Perfected*

# Plaster Stucco Reinforcement

The modern plaster base and reinforcement a combined lath, reinforcement and base for plaster, cement and stucco. An electric welded mesh of cold drawn galvanized steel wire backed by tough waterproof kraft paper. Plasters quickly and without effort.

Send for free literature fully describing.



## American Steel & Wire Company's

THE COMMON NAIL  
IS LIKE COMMON  
SENSE - NOT SO  
COMMON.  
READ ABOUT  
THE DIFFERENCE

A BAD  
NAIL

A GOOD  
NAIL

## Super-Quality Wire Nails

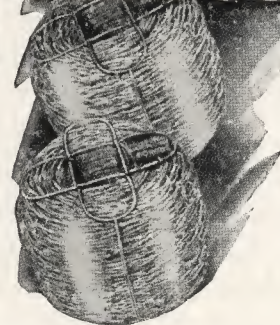
The wire nail in its many forms for all purposes is now acknowledged as the standard of nail usage throughout the world. Its remarkable adaptation to many uses and its rugged efficiency has tended to avoid, with many people, any thought of discrimination in its manufacture. Yet there is as much difference in the care employed in making wire nails as in anything else that is made by machinery. The cost of nails is usually the lowest item on a job, due to the economies of large wire production.

The primary value of a nail is in the quality of the steel and in the perfect drawing of the wire, then in the shaping of the head and the cutting of the point. Where the hard steel quality is used in the wire, which is most requisite and necessary for the stiffness of the nail, the shaping of the head and the cutting of the point is naturally difficult and expensive; which if a softer quality of steel is used, it is easier and cheaper. Hence the basic merit of the nail is least apparent on sight—it is hidden in the sturdy character of the hard steel that is demonstrated only in driving. There is real economy in buying this quality as the softer quality may spoil a job and the consequent damage done makes it high at any price.

The heads and points of our nails are shaped from the hard, sturdy steel, by the most deft machinery, under the keen supervising eye of inspectors. Study an American Steel & Wire Company's nail, note the clean, sharp point, the firm set head showing ample metal, the well punched barbing, the accurate gauge, and above all test that which does not appear at first glance—the great strength of the steel that holds straight in driving according to the work for which intended. And further, our nails are packed full weight, 100 pounds net, in each keg.

American Steel & Wire Company's

## American Barbed Wire



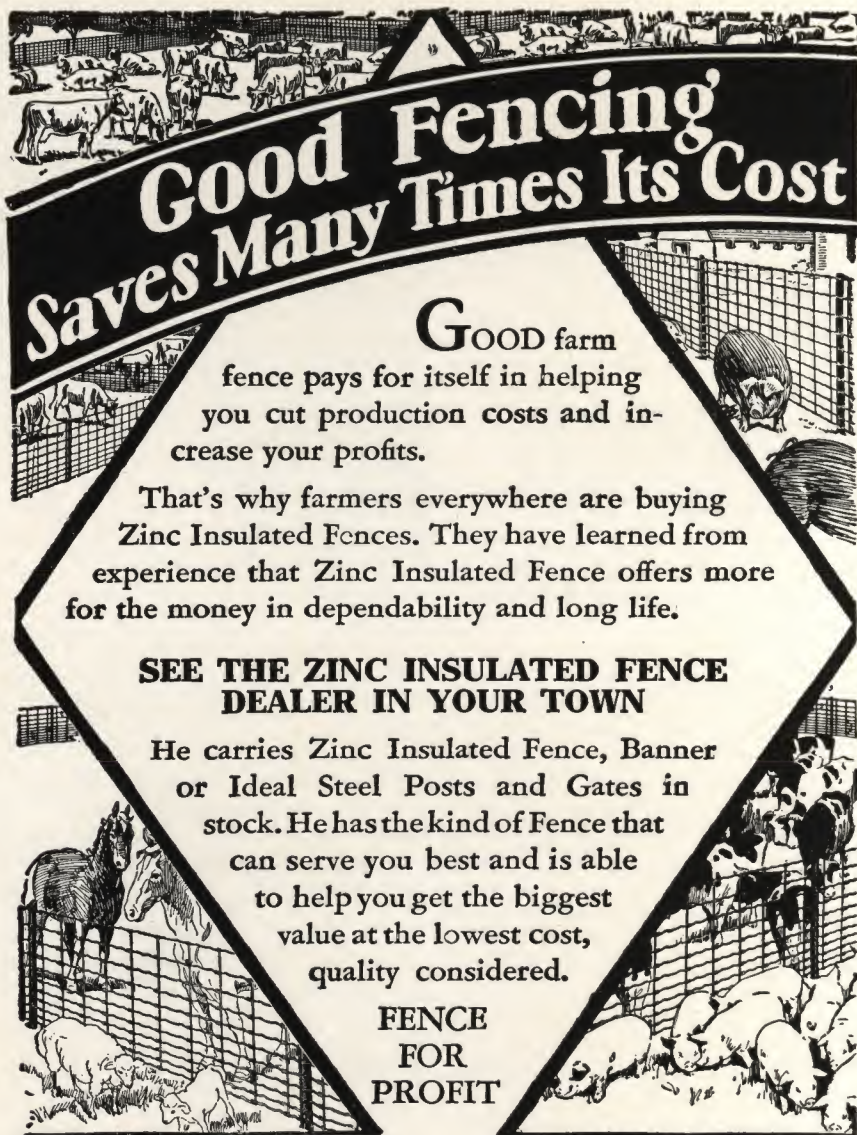
WE are the originators of barbed wire, and our mills making it today are the same ones first employed to produce it. Barbed wire is one of the most practical of inventions and its claim for extensive usage is based upon its utility, low cost and durability.

All brands of barbed wire made by us are plainly stenciled with the brand and registered trade marks. Customers who want good quality should insist on getting our well-known brands. Our motto is "KEEP UP THE QUALITY."

Made in the following standard brands:

American Glidden  
Ellwood Glidden  
Baker Perfect  
Waukegan 2-point  
Lyman 4-point  
Waukegan 4-point  
American Special 2-point.

Catalogue on request.



**Good Fencing'  
Saves Many Times Its Cost**

**GOOD** farm fence pays for itself in helping you cut production costs and increase your profits.

That's why farmers everywhere are buying Zinc Insulated Fences. They have learned from experience that Zinc Insulated Fence offers more for the money in dependability and long life.

**SEE THE ZINC INSULATED FENCE DEALER IN YOUR TOWN**

He carries Zinc Insulated Fence, Banner or Ideal Steel Posts and Gates in stock. He has the kind of Fence that can serve you best and is able to help you get the biggest value at the lowest cost, quality considered.

**FENCE  
FOR  
PROFIT**

## **Zinc Insulated Fences**

*In the following brands:*

**AMERICAN, ROYAL, ANTHONY,  
U. S., NATIONAL, MONITOR  
and PRAIRIE**

# Banner Posts

## *The Post with a Backbone*

Banner Posts with their railroad rail design and large slit-wing patented anchor plates, root firmly into the ground, hold the fence securely in line and give many years of service. Notches frequent enough to fasten every line wire. Seven Banner wire clamps are furnished free with each post.

Furnished in light gray painted or galvanized.



# Ideal U SHAPE STEEL FENCE Posts



Made from new steel rolled into a channel or trough section, commonly called a "U." This type of section has long been used in ships and bridges and in its modified form it makes an unusually attractive fence post both from standpoint of strength and appearance. The posts are rolled in our own mills from specially selected steel which is exactly right for the purpose.

Large anchor plate—increased ground facing does away with the shearing point.

Fence easily stretched and held in place by special loop clamps, seven of which are furnished free with each post.

Painted willow green, baked on under high temperature.









